

Name _____	Date _____
Partner _____	Teacher _____

Safety in the Biology Laboratory

Lab is an integral part of any biology course. Biology is a laboratory science and requires a lab class which permits and encourages discovery and creativity. The biology lab enables you to understand in more practical and concrete ways your own biological makeup, environmental issues, health concerns, etc.

"A lab is where you do science and are able to see and feel what otherwise can only be talked about."

A. GENERAL LABORATORY RULES

The biology lab is a place for learning. It must also be a safe place. Safety guidelines provide a framework for establishing a respectful and responsible class attitude. Safety precautions also make you aware of the possible dangers in various science experiments. You owe it to yourself and your classmates to practice the all safety procedures.

1. Eating and drinking is not permitted in the Biology Lab. Nothing should be placed in or near your mouth: lipstick, pens, pencils, etc.
2. Do not work in the lab without permission and presence of your teacher.
3. Perform only assigned laboratory activities. Read all labels and directions carefully.
4. Report all personal injuries or conditions which appear to be unsafe to your teacher.
5. Report open or bandaged cuts to the teacher before class begins.
6. Report unusual odors in the laboratory to your teacher.
7. Know the location of all laboratory emergency safety equipment, disposal procedures and evacuation routes.

Fire Exits _____
Fire Extinguisher _____
First Aid Kit _____
Emergency Eye Wash _____
Emergency Shower _____
Fire Blanket _____

8. Wear acceptable clothing and required protective covering while working in the laboratory.
9. Take precautions to protect skin, clothing and belongings from contamination.
10. Wear appropriate safety goggles near hazardous chemicals and other potential eye hazards.
11. All aisles in the laboratory must be kept open at all times.
12. Stay out of restricted areas.
13. Keep personal belongings out of the work area.
14. Wash hands and thoroughly clean work area before leaving the laboratory.
15. Glassware, equipment, lab tabletops and countertops must be clean before you leave the lab.
16. Keep sinks free of paper and debris which will clog them.

B. HEATING PROCEDURES

Laboratory activities that involve heating substances are potentially hazardous. Accidents can occur that cause minor burns on the skin or set clothing or chemicals on fire. Special care must be taken when using a heat source.



1. Wear safety goggles and an apron whenever heating substances in the lab.
2. Always handle hot test tubes or glassware with tongs or a hot mitt. Never handle heated equipment with your bare hands.
3. When heating chemicals in a test tube, always point the open end of the test tube away from yourself and others. Follow safety directions for heating various substances.
4. Keep inflammable substances, such as alcohol, away from an open flame.
5. If you are heating something at your laboratory work station, do not leave it unsupervised.

6. If someone's clothing catches on fire, smother the fire with a blanket. Notify your teacher or laboratory instructor immediately.

C. WORKING WITH CHEMICALS

Not all chemicals are dangerous. Some chemicals, such as acids and bases, are caustic and can irritate your skin or burn your clothing. Other chemicals are ~~inflammable- easily set on fire, or are toxic - give off poisonous odors.~~ In the biology lab we use chemical stains. These stains will temporarily stain your skin and damage your clothing. Special precautions must be taken when chemicals are used.

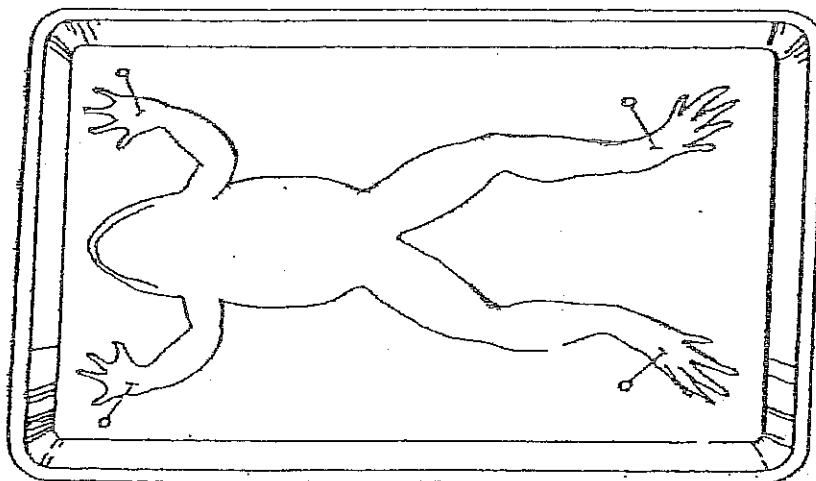
1. Be aware of any warnings given in a laboratory activity about chemicals.
2. Follow the procedure for working with particular chemical substances.
3. When pouring chemicals from one container to another, be careful to avoid spills or drips. Wipe up any chemical spill immediately. Report the spill to your teacher.
4. Wear safety goggles when working with caustic chemicals.
5. Never taste a chemical or inhale the vapors from a chemical. It can be toxic.
6. Do not mix chemicals together unless you are directed to do so as part of the laboratory procedure.
7. Never add water to acids or bases.



D. DISSECTION PROCEDURES

The sharp points or edges of dissecting instruments are another potential hazard. To avoid accidents, follow the safety guidelines for using dissecting instruments, and always wear safety goggles when working with specimens.

1. Read and follow proper dissecting procedures.
2. Be sure a specimen is mounted before dissecting it. Never hold a specimen in your hand while dissecting.
3. Handle your instruments with care. Do not let other students crowd around you while you are dissecting a specimen.
4. Wash your hands thoroughly after dissecting.



Analysis: Answer the following questions in complete sentences.

1. Describe the first procedure you should begin with in the laboratory period.

2. What safety procedures should you follow at the end of a laboratory session?

3. Name four types of equipment that serve as protection when heating chemical substances.

4. How should you handle the test tube in which you are heating a chemical?

5. Why is it important to keep some chemicals away from an open flame?

6. Describe what action you would take if someone's clothing caught on fire in the laboratory.

7. What should you know before starting an experiment that involves chemicals?

8. A small amount of chemical spills at you work station. What should you do?

9. Why should you never taste a chemical, or inhale vapors from a chemical?

10. Why should specimens be mounted before dissection?

11. Describe the care that should be taken in using dissection instruments?

- 6.
12. In the space below, draw the layout of your classroom. Note the location of all safety equipment. Refer back to Section A for suggestions.
-
-
-

Student Safety Agreement

I, _____, have read
(please print full name)

the "Safety in the Biology Laboratory" pages of this manual, understand its contents completely, and agree to demonstrate compliance with all safety rules and guidelines that have been established in each of the following categories:

- ☐ General Laboratory Rules
- ☐ Heating Procedures
- ☐ Working with Chemicals
- ☐ Dissection Procedures

(signature)

(date)

As a parent / guardian, I _____ understand that
(please print full name)

my child has read the "Safety in the Biology Laboratory" pages and is responsible for following these rules at all times.

(signature)

(date)

Name _____ Lab Period _____

** This activity is modified for local district use from an activity posted by Mr. Michael Comet at South Lewis CS, Turin, NY.

Lab Safety Activity

Objectives: Upon completion of this laboratory experience the student will:

- 1.) know the rules and regulations that help keep the biology laboratory a safe place to work.
- 2.) be able to identify major hazards and to implement a plan to react and respond if a hazardous condition presents itself.

Some Laboratory Rules

After reading the following rules, state one major reason why that rule is important.


Rule	Why is it Important?
At the beginning of most laboratories, your instructor will engage in a pre-lab discussion. Many safety procedures will be discussed during these discussions.	
Keep all books, papers, and other flammable materials away from open flames or dangerous chemicals.	
Tie back long hair when you are working with an open flame.	
Do NOT mix chemicals or perform unscheduled experiments without your teacher's approval	
Never use chemicals from an unlabeled container. Do not taste, smell, or touch chemicals unless specifically instructed by your teacher to do so.	
Wear safety goggles during experiments involving heating or hammering or while using acids or bases. If you do not have goggles on, stay away from students that are experimenting.	
It is also expected that you will wear goggles when working near caustic or volatile chemicals. (including dissections)	
Point the open end of a test tube or flask away from yourself and others while heating it. Never heat a closed test tube or container.	
Use squeeze bottles and droppers only for their intended purpose.	

9.

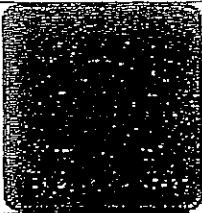



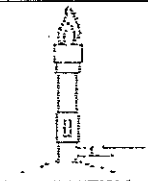
Name _____ Lab Period _____

Use a lubricant when inserting glass tubing into a stopper. .	
Use tongs or other safety equipment when picking up red hot materials. .	
Clean up loose material should be left in the sinks and lab benches. ; i.e. paper, lab equipment, etc.	
Discard all waste matter in the appropriate containers. (ex. glass in glass pail	
Never place pencils, pens, or other materials in your mouth.	
NEVER return excess chemicals back to their container.	
Gas burners and hot plates must be turned off when not in use during the laboratory period.	
Keep volatile liquids and reagents away from the bunsen burner flame or other heating source.	
Know where all laboratory safety equipment is located in case you need it.	
Most chemical spills are best handled by washing the affected area with water as quickly as possible. Call your teacher for assistance if necessary. Severe spills may require the removal of clothing.	
Put out any fires immediately. Call your teacher for assistance if necessary.	
In an emergency situation do not panic. If you observe another student in trouble, tell them what to do, and assist them in doing it.	

Laboratory Safety Symbols

Symbol	What does the symbol mean?
	

Name _____ Lab Period _____

	
	
<p>DANGER</p>  <p>POISON</p>	
	
	

Conclusion Questions:

1. How do you exit this room in case of a fire or fire drill? Be specific, describing the exit route and at least three exit procedures to be followed.
2. Describe at least three things that you would recognize as being hazards that could exist in the lab. What would you do about correcting the hazard?

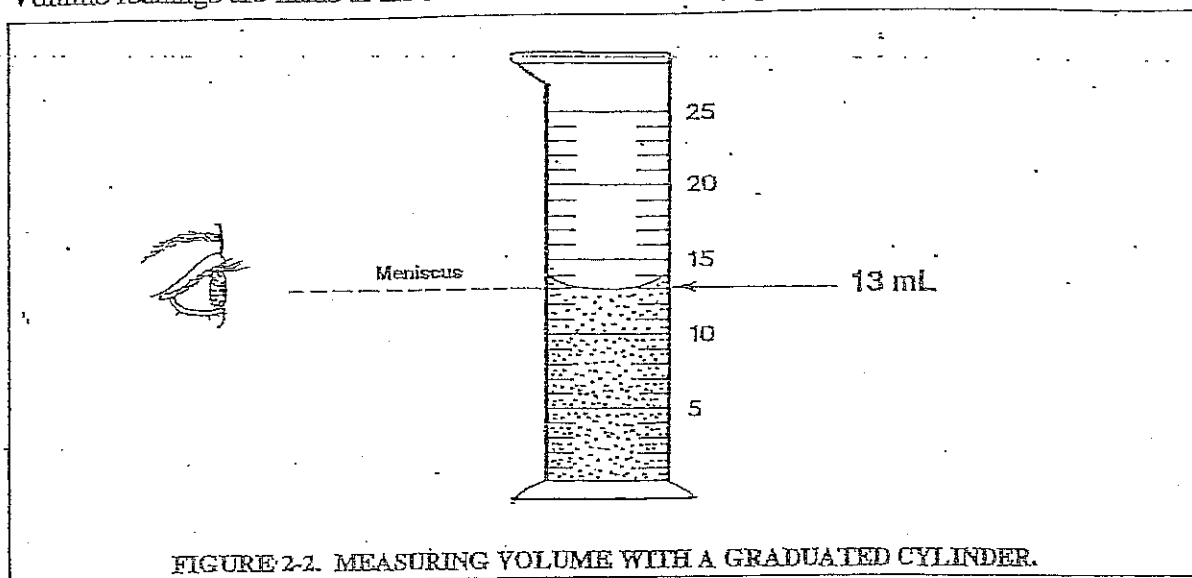
Measurement lab

NAME: _____

DATE: _____

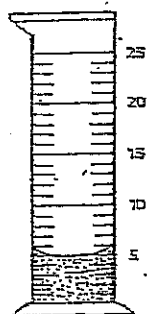
LAB# _____

MEASURING VOLUME. The volume of a liquid is measured with a graduated cylinder. When liquid is poured into the cylinder, a curved surface called the meniscus is formed. Volume readings are made at the bottom of the meniscus (Figure 2-2).

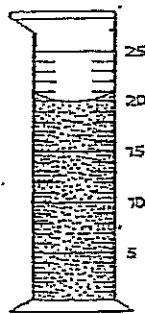


REVIEW QUESTIONS

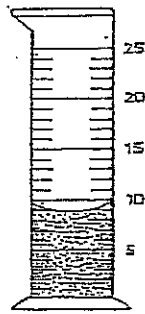
1. In the diagram above, the volume of water is _____ mL.
2. A _____ is used to measure liquids in the laboratory.
3. A meniscus is a _____ surface.
4. Volume readings are made at the _____ of the meniscus.
5. Find the amount of liquid (to the nearest milliliter) in each of the graduated cylinder sections shown below.



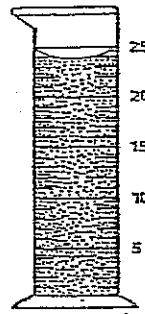
a. _____



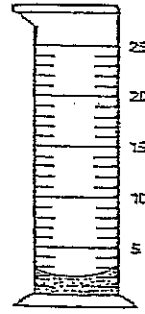
b. _____



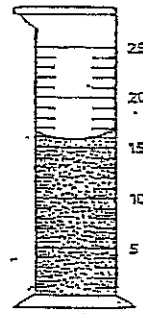
c. _____



d. _____



e. _____



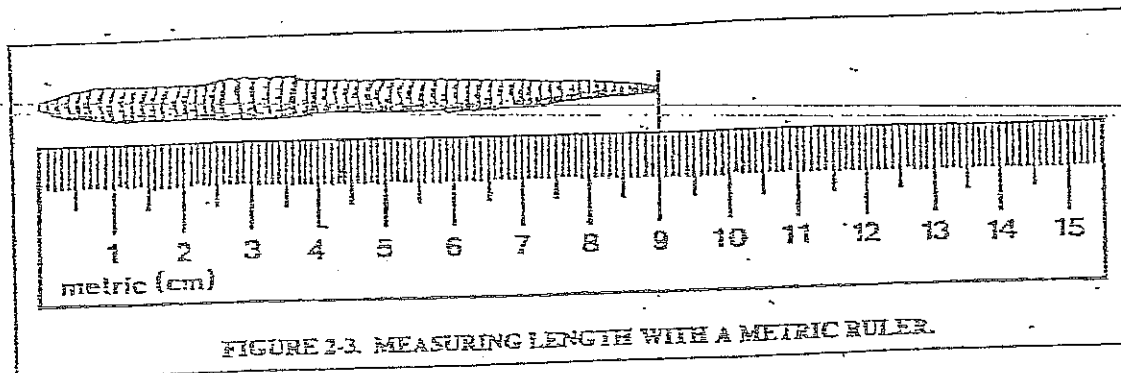
f. _____

NAME: _____

DATE: _____

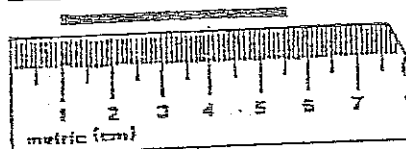
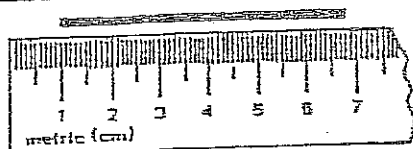
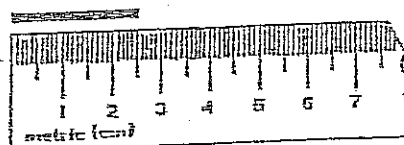
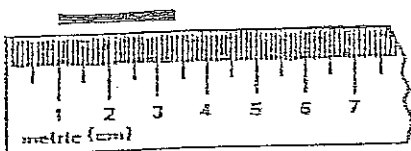
LAB# _____

MEASURING LENGTH. The metric ruler is used in the laboratory to measure length. The most common units used to measure length are the centimeter and millimeter. The worm in Figure 2-3 measures 9 centimeters, or 90 millimeters.



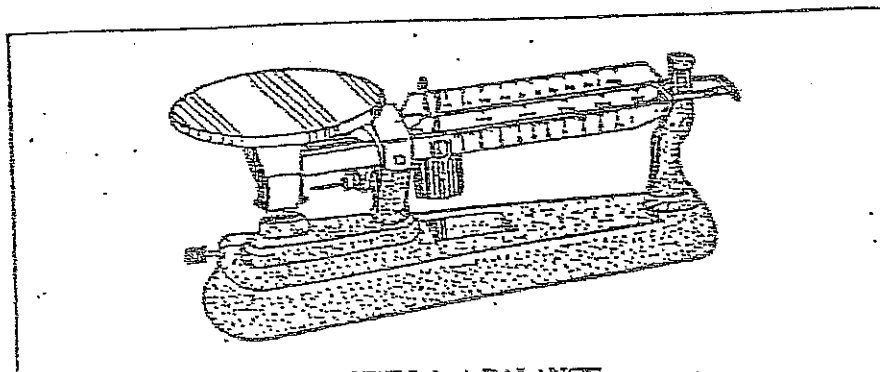
REVIEW QUESTIONS

1. The _____ is used in the laboratory to measure length.
2. Below are drawings of metric rulers. Write the length of each object in the space provided.



MEASURING WEIGHT (MASS). Materials are weighed in the laboratory by using a balance. The balance compares the weight (mass) of the object to be weighed with the weight of known objects called

weights. Figure 2-4 is an example of one type of balance found in biology laboratories. Your school may have other types of balances.



NAME: _____

DATE: _____

LAB# _____

REVIEW QUESTIONS

1. A balance is used in the laboratory to measure _____.
2. The balance compares the weight (mass) of _____ w.
weight of _____.

MEASURING TEMPERATURE. A Celsius or centigrade thermometer is used to measure temperature (Figure 2-5). On the Celsius or centigrade scale, 0 degrees is the freezing point of water and 100 degrees is the boiling point of water. The divisions on the thermometer are called cent degrees of $^{\circ}\text{C}$.

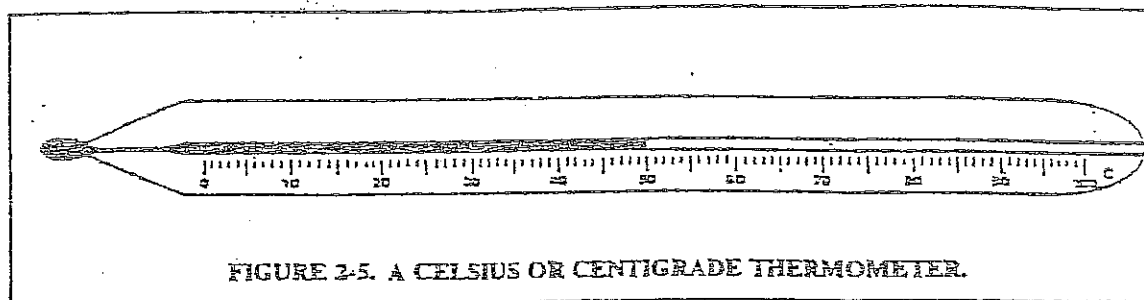
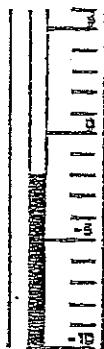


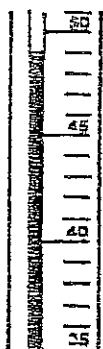
FIGURE 2-5. A CELSIUS OR CENTIGRADE THERMOMETER.

REVIEW QUESTIONS

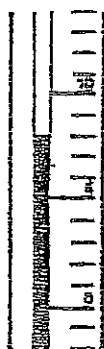
1. A _____ or _____ thermometer is used to measure temperature in the laboratory. _____ is the freezing point of water and _____ degrees is the boiling point.
2. What is the temperature in degrees Celsius indicated on the thermometer in Figure 2-5?
3. In the spaces provided write the Celsius temperatures shown in each of the following diagrams.



a. _____



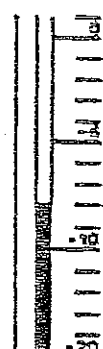
b. _____



c. _____



d. _____



e. _____



f. _____

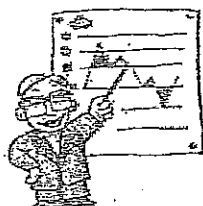
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Data Collection Date _____

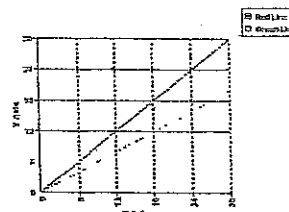
Class Period _____

Lab Period _____

Teacher _____



Graphs & Data Tables in Science



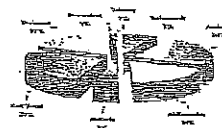
Background: One of the things most often seen in a description of any scientific experiment is a graph or table of some kind. A graph is a visual representation of numerical data collected from an experiment. Some of the types of graphs you'll find in science are bar and pie graphs. The one used most often (especially in Biology) is a line graph, and it is the type of graph we will create and analyze most during your Living Environment science class.

Line graphs describe the relationship between two (2) variables. Each variable is plotted along an axis. A line graph has a vertical axis and a horizontal axis. The "x-axis" is where scientists plot the independent variable and the "y-axis" is where they plot the dependent variable.

- They are good at showing specific values of data, meaning that given one variable the other can easily be determined.
- They show trends in data clearly, meaning that they visibly show how one variable is affected by the other as it increases or decreases.
- They enable the reader to make predictions about the results of data not yet collected.

Purpose: The purpose of this laboratory exercise is:

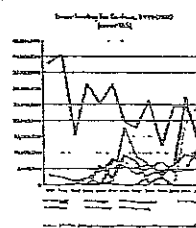
- to further refine our skills at graphing collected data
- to better understand how to "interpret" the data on a graph
- be able to graph data from a given table of raw data



Materials: The following materials are needed to complete this laboratory exercise;

- calculator
- graph paper
- pencils and pens
- this lab handout

Procedure: The following procedure is used to perform this exercise:



Part A: Interpreting Tables

1. What is a conclusion that can be drawn from data table 1.1 below?

- to answer this question, you must first compare sets of data from each column
 - First, what does the "Distance of Light from Plant" do as you read down the column?
 - Secondly, what happens to the "Bubbles per Minute" as you read down the column?
 - Lastly, your answer should include both trends.
- (Remember: data always shows us the relationship between two variable!)

Name _____

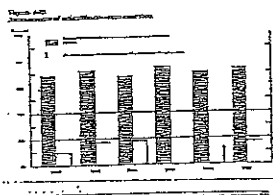
Data Collection Date _____

Class Period _____

Lab Period _____

Teacher _____

Data Table 1.1



Distance of Light From the Plant (cm)	Number of Bubbles per Minute Produced by Plant
10	60
20	25
30	10
40	5

2. Base your answers to questions 2-4 on Data Table 1.2 below.

Data Table 1.2

Test Tube	Temperature (°C)	Bubbles of Oxygen per Minute
1	0	3
2	10	22
3	20	40
4	30	58
5	40	71
6	50	2



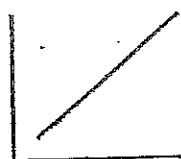
2. At what temperature will the most oxygen be produced? _____

3. Between which temperatures will oxygen production decrease? _____

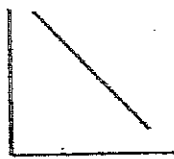
4. What is a conclusion that can be drawn from data table 1.2?

Part B: Interpreting Lines in Graphs

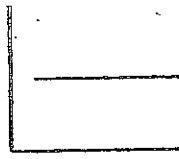
The following are a few examples of graph lines. These lines represent the RATE at which something occurs. In other words, it is "HOW MANY PER UNIT TIME"



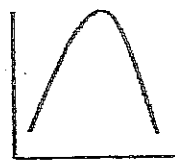
A



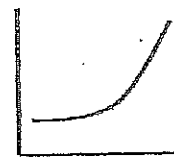
B



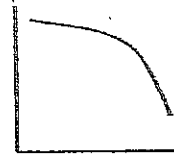
C



D



E



F

Name _____

Data Collection Date _____

Class Period _____

Lab Period _____

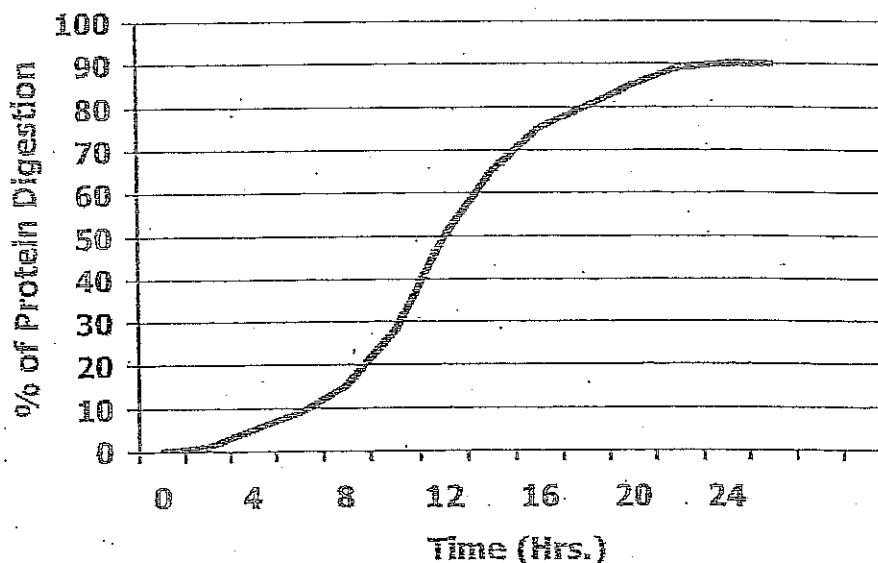
Teacher _____

5. Which line represents a tree which has not grown over time? _____
6. Which graph shows an increase, then decrease? _____
7. Which three (3) graphs show an increase in rate? _____
8. Which graph shows a constant rate increase over time? _____
9. Which graph shows a fast increase in rate that eventually remains constant? _____
10. Which graph shows a slow increase in rate that speeds up? _____

Part C: Determining Data from Graphs

Base your answers to questions 11-14 on the graph below.

The Rate of Protein Digestion



11. After four (4) hours has passed, what percent (%) of the protein has been digested? _____
12. How long does it take for 25% of the protein to be digested? _____
13. At which of the following time intervals does the most rapid increase in rate occur? _____
 a) 0-8 hours b) 8-16 hours c) 16-24 hours
14. At approximately how many hours does the rate of protein digestion remain constant? _____

Name _____

Data Collection Date _____

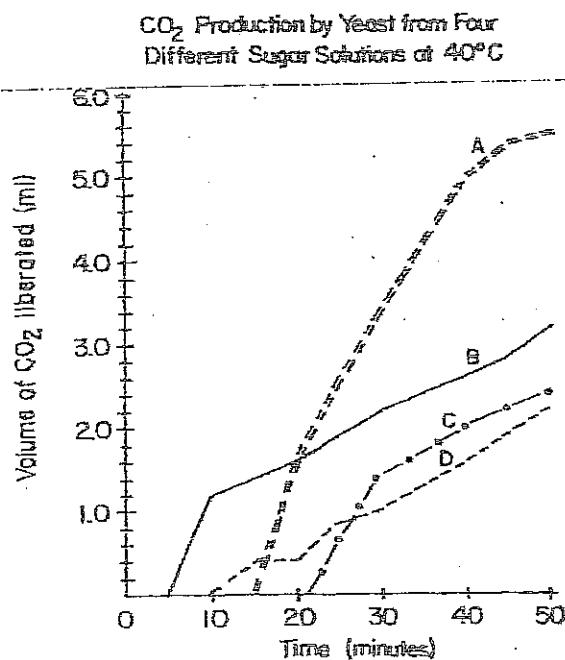
Class Period _____

Lab Period _____

Teacher _____

Part D: Interpreting Multiple Line Graphs

Base your answers to questions 15 and 16 on the following multiple line graph.

15. Which sugar solution was the first to liberate a measurable amount of CO₂?

15. _____

- 1) A
- 2) B
- 3) C
- 4) D

16. After how many minutes was the Volume of CO₂ liberated from sugar A Equal to the volume of CO₂ liberated from Sugar B solution?

16. _____

- 1) 5
- 2) 10
- 3) 20
- 4) 25

Part E: Creating Graphs

Complete the following graphing exercises using the data tables provided.

17. A group of biology students extracted the photosynthetic pigments from spinach leaves using the solvent acetone. A spectrophotometer was used to measure the percent absorption of six (6) different wavelengths of light by the extracted pigments. The wavelengths of light were measured in units known as nanometers (nm). One nanometer is equal to one-billionth of a meter. The following data was collected:

Wavelength(nm)	Percent Absorption
Yellow light (585)	25.8%
Blue light (457)	49.8%
Orange light (616)	32.1%
Violet light (412)	49.8%
Red light (674)	41.0%
Green light (533)	17.8%

(continued on page 5)

Name _____

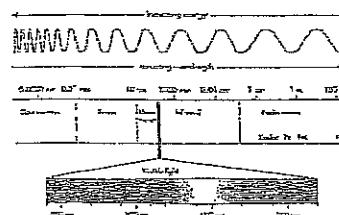
Data Collection Date _____

Class Period _____

Lab Period _____

Teacher _____

Part E: Creating Graphs (cont.)



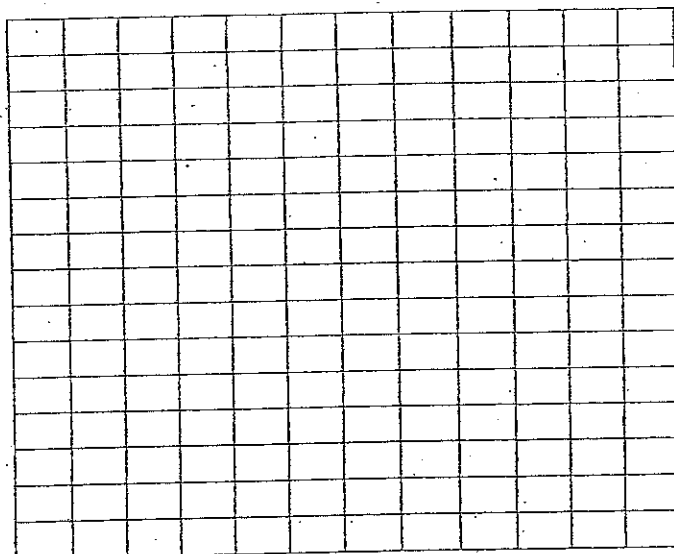
- record the raw data collected in the table below so that wavelengths are increasing.

Color of Light	Wavelength of Light (nm)	Percent Absorption by Spinach Extract

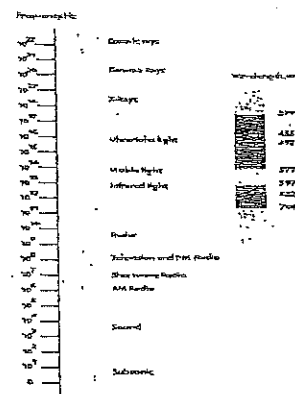
- Plot the data from the data table above on the following graph:

P
e
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c
e
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t

A
b
s
o
r
p
t
i
o
n



Wavelength of Light (nm)



Name _____

Data Collection Date _____

Class Period _____

Lab Period _____

Teacher _____

18. What wavelength of light does spinach leaves absorb best? _____

19. What color light does spinach leave absorb the least? _____

20. What is a conclusion that can be drawn from the graph?

Graphing Activity

Introduction

Graphing is used by scientists to display the data that is collected during a controlled experiment. A line graph must be constructed to accurately depict the data collected. An incorrect graph may often lead to the acceptance of an incorrect hypothesis or detract from the acceptance of a correct hypothesis.

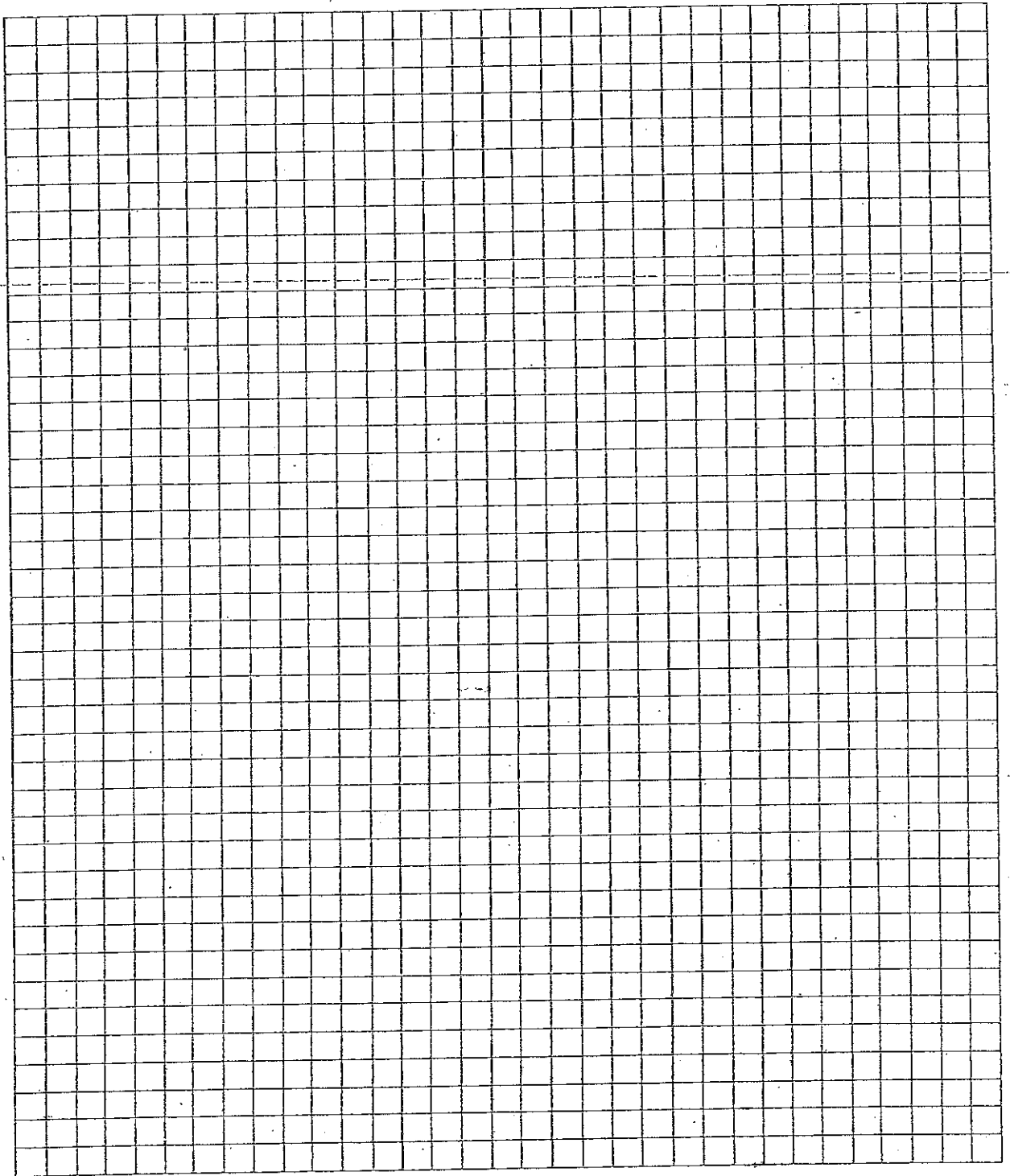
The graph should contain 5 major parts. These are the title, the independent variable, the dependent variable and the scales for each variable:

- 1.) **The title:** this shows what the graph is about. Reading the title should give the reader an idea about the graph. It should be a concise statement placed above the graph.
- 2.) **The Independent Variable:** this is the variable (part of the experiment that changes) that can be controlled or manipulated by the experimenter. This variable should be placed on the horizontal or x-axis.
- 3.) **The Dependent Variable:** this is the variable directly affected by the independent variable. It is the result of what happens because of the independent variable. This variable is placed on the y or vertical axis.
- 4.) **The Scales for each Variable:** In constructing a graph, one needs to know where to plot the points representing the data. In order to do this a scale must be employed that will include all the data points. Each block should have a consistent amount or increment on a particular axis. While the scale should allow as much of the graph to be taken up as possible, it is not a good idea to set up a scale that is hard to manage. For example, multiples of 5, 10, etc. are good, while multiples such as 1.22 are not! Your scale must be plotted on the amount of graph space available, and will be dictated by the data points.

Graphing Question Set # 1

1. Use the data in the table below to complete the graph provided. Remember to title your graph, label the axes properly when setting up your scale, make a key, and to write a legend for your graph when completed.

Depth in meters	Number of bubbles/min Plant A	Number of Bubbles/min Plant B
2	29	21
5	36	27
10	45	40
16	32	50
25	20	34
30	10	20



Answer the following questions based on the graph above you just completed.

2. What is the independent variable?

3. Why is this the independent variable?

4. What is the dependent variable?

5. Why is this the dependent variable?

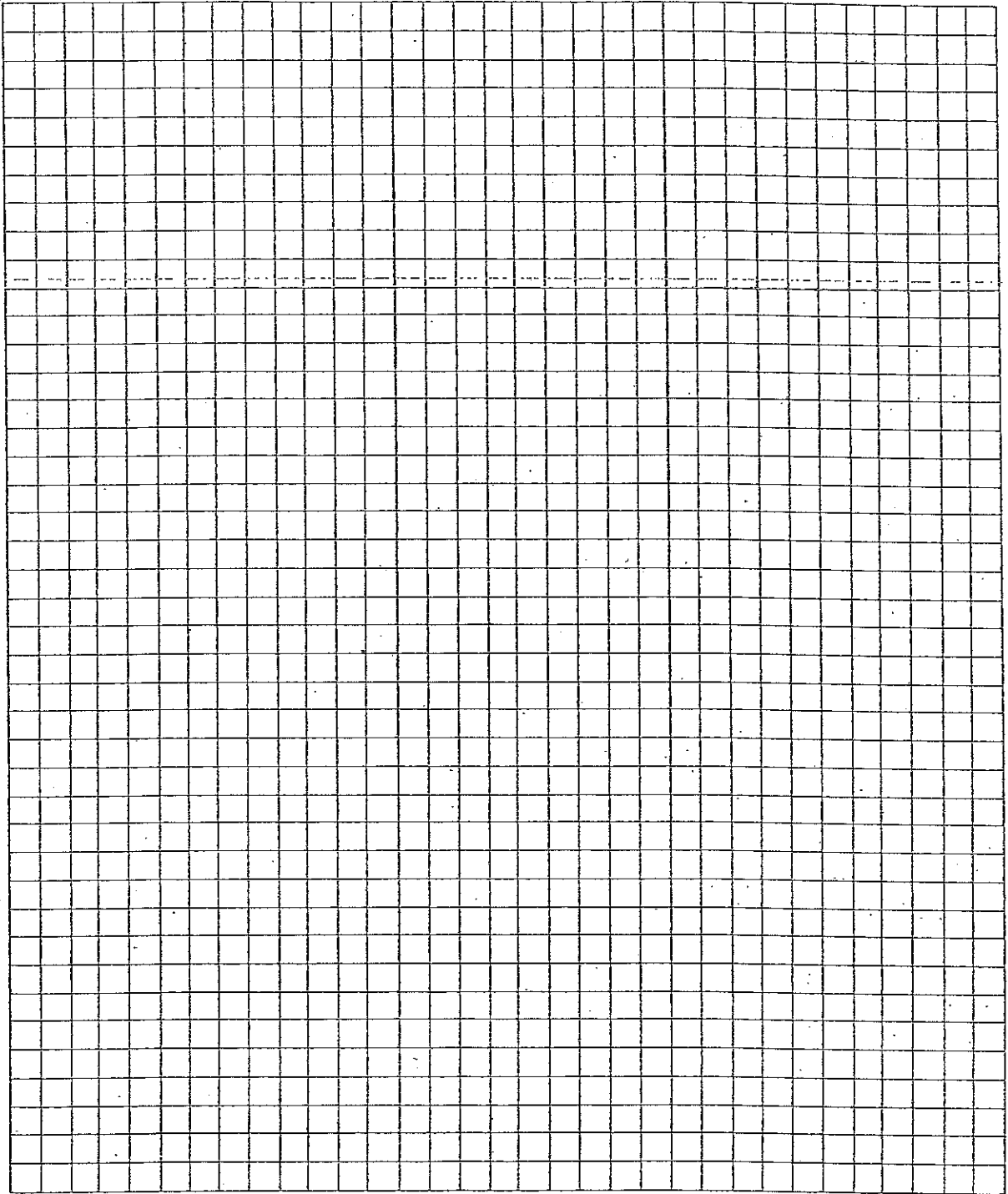
6. Use one or more complete sentences to state a conclusion about the data in graph # 1.

Graphing Question Set #2

Diabetes is a disease affecting the insulin producing glands of the pancreas. If there is not enough insulin being produced by the cells, the amount of glucose in the blood will remain high. A blood glucose level above 140 for an extended period of time is not considered normal. This disease, if not brought under control, will lead to severe complications and even death.

1. Use the data in the table below to complete the graph provided. Remember to title your graph, label the axes properly when setting up your scale, make a key, and to write a legend for your graph when completed.

<u>Time After Eating</u> <u>(hrs.)</u>	<u>Glucose Level in</u> <u>ml/liter of blood in</u> <u>person A</u>	<u>Glucose Level in</u> <u>ml/liter of blood in</u> <u>person B</u>
0.5	170	180
1	155	195
1.5	140	230
2	135	245
2.5	140	235
3	135	225
4	130	200



Answer the following questions based on the graph above you just completed.

2. What is the independent variable?

3.. What is the dependent variable?

4. Which, if any of the above individuals has diabetes? Be sure to justify your answer!

5. If the time period were extended to 6 hours, what would be the expected blood sugar level for Person B? _____

6. What would be a probable blood sugar level for person B at 3.5 hours? _____

7. Use one or more complete sentences to state a conclusion about graph #2.



Gummy Bear Lab

Name _____

Vocabulary: define the following terms

1. Hypothesis
2. Independent variable
3. Dependent variable
4. Constant
5. Control

Part A: Choose one gummy bear from the container on your table. Use the equipment available to measure your gummy bear and record the data in the chart for Day 1.

Measurements:

- The length of your gummy bear should be measured from the top of its head to the bottom of its feet to the nearest tenth of a centimeter.
- Measure the width at the widest point across the back of the bear to the nearest tenth of a centimeter.
- Measure the thickness from the front to the back at the thickest point to the nearest tenth of a centimeter.
- Calculate the volume by multiplying the length, width, and thickness. Round to the nearest hundredth.
- Measure the mass using a triple-beam balance or other scale to the nearest tenth of a gram.
- Calculate the density by dividing the mass by the volume. Round answer to the nearest hundredth.

Part B: Put the bear in a cup labeled with your name and class period. Add 50 ml of water to the cup and allow it to sit overnight. On Day 2, remove the gummy bear from the cup of water and use a towel to dry it off to prevent it from dripping all over the place. Repeat the measurements from Part A and record your data in the correct portion of the chart. Determine the amount of change for each measurement and record in the chart.

Experiment Data:

		(L)	(W)	(T)	(LxWxT)	M	M/V
Day	Bear Color	Length	Width	Thickness	Volume	Mass	Density
1							
2							
Amount of change							

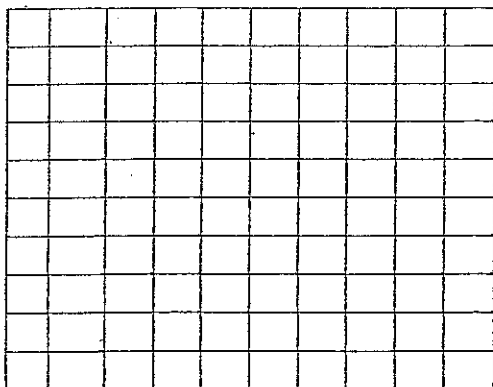
Problem: What are the effects of putting a gummy bear in the water overnight?

Day 1:

1. Draw or trace a picture of your gummy bear in actual size.
 2. Develop a hypothesis that addresses the problem on the previous page. This should involve the appearance, volume, mass, or density of the gummy bear – you choose.
-
3. For the gummy bear experiment, what will your independent variable be?
 4. What will your dependent variable be?
 5. What is your control variable in this experiment?
 6. What factors (at least two) should be kept constant in both the experimental and the control groups?

Day 2:

1. Design a graph that best illustrates your data.



2. What is your conclusion? Did your hypothesis hold true?
3. Develop an inference about gummy bears based on your experiment.
4. What could you do to further improve the results of this experiment?

1-2 How Are SI Length Measurements Made?

Often measurements are made to learn more about biological problems. The International System of Units, or SI, is a system of measurements you will become more familiar with this year. The measurements you will make in this exercise are SI measurements.

In this exercise, you will make length measurements. The basic unit of length is the meter. The meter is divided into one hundred smaller units called centimeters. Smaller measurements are made with millimeters. Ten millimeters equal one centimeter.

When measurements are made, you should write them down. Data are observations you record—in this case, the measurements you write down. The data will be written in a table to help you keep them organized.

GOALS

In this exercise, you will:

- compare hand and foot bones.
- record your data in tables and draw conclusions.

KEYWORDS

Define the following keywords:

data _____

length _____

meter _____

SI measurements _____

MATERIALS

metric ruler

PROCEDURE

- Look at the diagram of the hand in Figure 1 on page 6. Count the number of bones present in the thumb, fingers, palm, and wrist. (They are shaded in different ways in the diagram to help you.) Record your counts in Table 1.

Table 1. Bone Counts

Part	Number of bones	Part	Number of bones
Thumb		Big toe	
Fingers		Other toes	
Palm of hand		Center of foot	
Wrist		Ankle and heel	

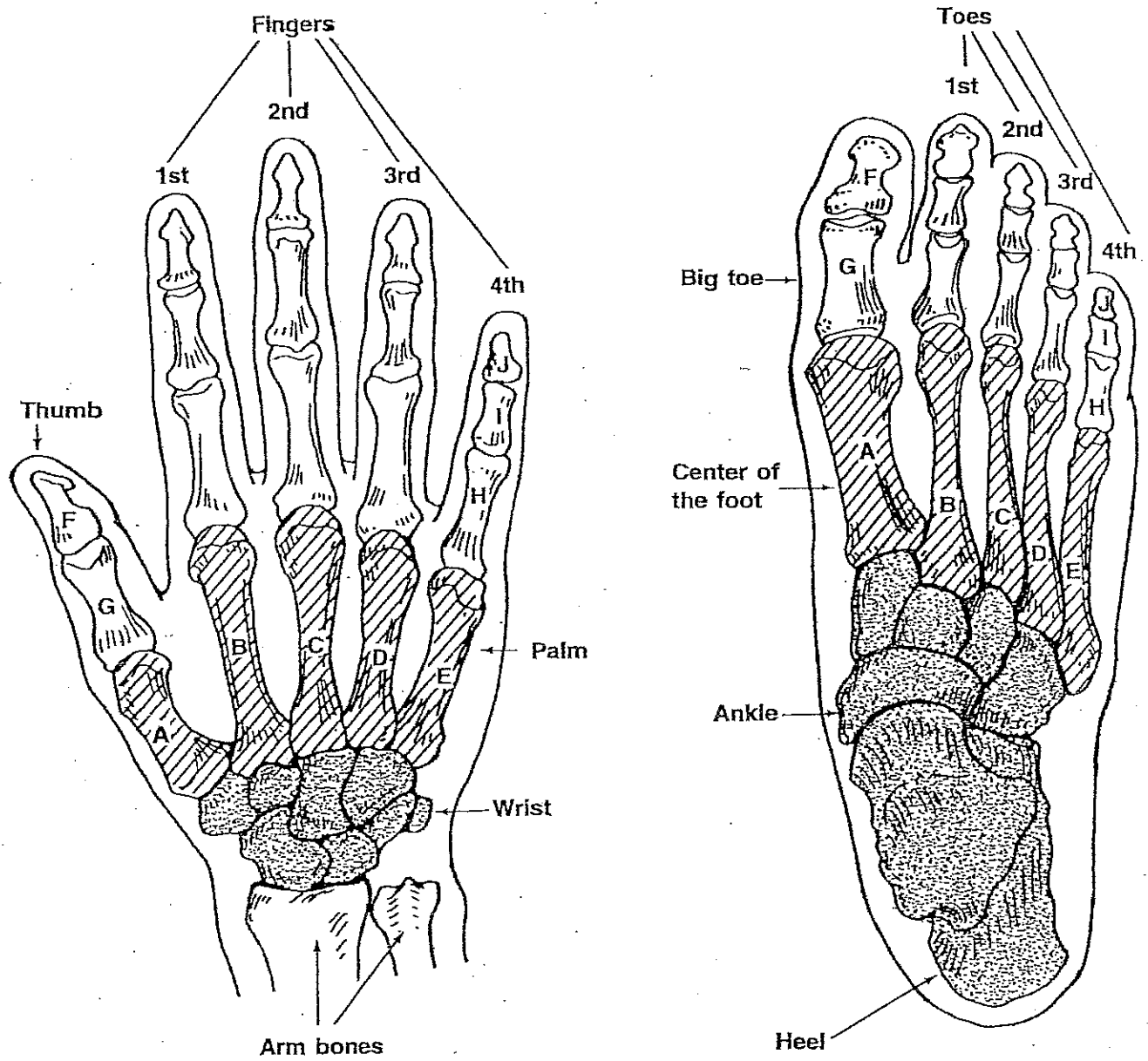


FIGURE 1.

2. Measure in millimeters the lengths of the bones marked A, B, C, D, and E in the hand diagram. Record your measurements in Table 2.
3. Measure in millimeters the lengths of the bones marked A, B, C, D and E in the foot diagram. Record your measurements in Table 2.
4. Measure the length of the thumb (F+G) and record the number in the table.
5. Measure the length of the big toe (F+G) and record it in the table.
6. Measure the lengths of the smallest finger and toe (H+I+J). Record these data in the table.
7. Change all the millimeter measurements to centimeter measurements in the table. Recall that there are ten millimeters in one centimeter.

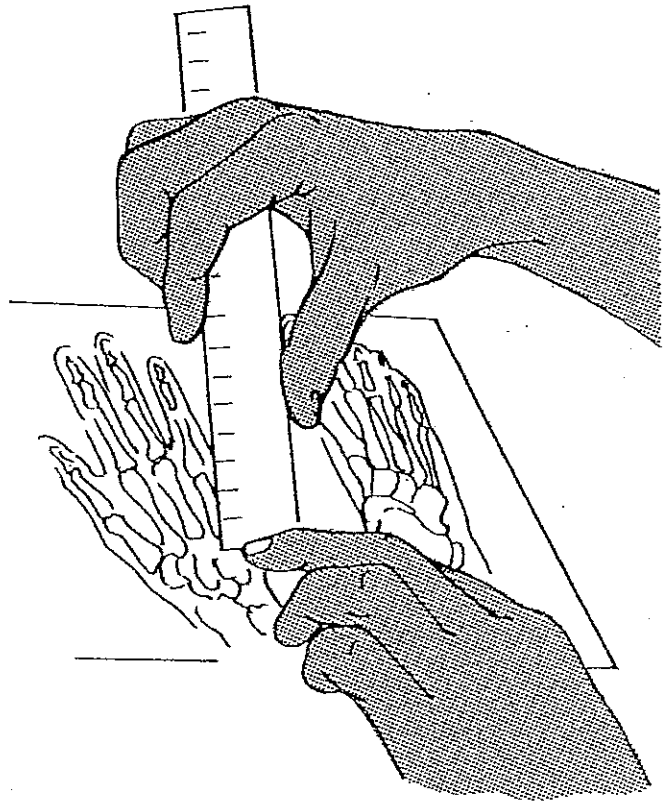


FIGURE 2. Measuring bone length

Table 2. Bone Lengths

Bone	Hand		Foot	
	Millimeters	Centimeters	Millimeters	Centimeters
Bone A				
Bone B				
Bone C				
Bone D				
Bone E				
Thumb or big toe bones (F+G)				
Smallest finger or toe bones (H+I+J)				

QUESTIONS

1. What is the total number of bones:
a. in the hand? _____ b. in the foot? _____
2. How do the total number of bones in the hand and foot compare? _____

3. What is the total number of bones in the:
a. palm? _____ b. center of foot? _____
4. How do the total number of bones in the palm and foot center compare? _____

5. What is the total length of:
a. bone A in the hand? _____ b. bone A in the foot? _____
6. How much longer is bone A in the foot than bone A in the hand? _____

7. What is the total length of the:
a. little finger? _____ b. little toe? _____
8. How much longer is the little finger than the little toe? _____

9. Describe the main differences between the lengths of the bones in the hand and the foot. _____

10. Why are data often kept in tables? _____

11. Suppose you were working in a department store. What unit of measurement (meter, centimeter, millimeter) would you use to measure the length and width of shoes and window curtains? _____

12. How are SI length measurements made? _____

Name _____

Date _____

Using SI Units

5

How many inches equal one foot? How many feet equal one yard? Almost everybody can answer these questions. But how many yards equal one rod?

Is there any one number that is common for changing inches to feet, feet to yards, or yards to rods? A problem with the English system for measuring is that there is no common number for changing one unit to another. As a result, you may have had difficulty remembering that there are $5\frac{1}{2}$ yards to a rod.

Biologists and other scientists use the SI system of measuring rather than the English system. SI is an abbreviation for the International System of Measurement. SI is a more modern version of the old metric system.

In this investigation, you will

- (a) identify and use SI units of length and volume to measure several objects.
- (b) learn two important rules for converting from one SI unit to another.

Materials

metric ruler
50-mL graduated cylinder
microscope slide

Procedure

Part A. Measuring Length in SI Units

How tall are you? How wide is your classroom? What is the size of your desk top? How long are pine tree needles? Getting answers to these questions involves measurements of distance or length. What unit in the SI system is used to measure length?

- Examine a metric ruler. Starting at the left edge, locate the smallest division or mark. This unit is the millimeter (mm). Ten millimeters are equal to a unit called the centimeter (cm). The ruler will have a longer line and the number 1 marked at the 1 cm length (Figure 5-1).

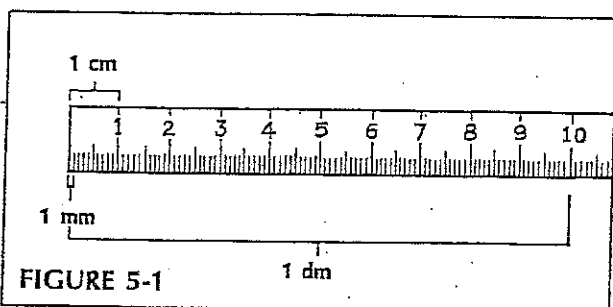


FIGURE 5-1

1. How many millimeters equal 1 cm? _____
2. How many millimeters equal 3 cm? _____
3. What number is used in changing the number of millimeters to centimeters? _____

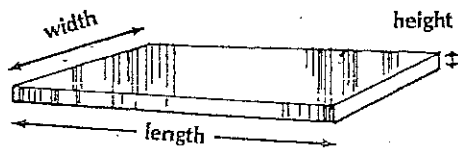
Ten centimeters are equal to one decimeter (dm). Ten decimeters are equal to one meter (m).

4. What number is used when changing
 - (a) centimeters to decimeters? _____
 - (b) decimeters to meters? _____

- Measure a microscope slide in millimeters. Use Figure 5-2 as a guide to length, width, and height. Record these values in the column marked "mm" of Table 5-1.

- To convert your millimeter numbers to centimeters, divide the millimeter numbers by 10. Record the length, width, and height of your slide in centimeters. Use the column marked "cm" of Table 5-1.

FIGURE 5-2



• To convert your centimeter numbers to decimeters, divide the centimeter numbers by 10. Record the length, width, and height of your slide in decimeters. Use the column marked "dm" of Table 5-1.

• To convert decimeters to meters, divide decimeters by 10. Record your slide measurements in meters on Table 5-1 in the column marked "m."

TABLE 5-1. MICROSCOPE SLIDE MEASUREMENTS

	mm	cm	dm	m	km
Length					
Width					
Height					

A unit, kilometers, often is used to measure long distances. 1000 meters equal 1 kilometer (km).

• To convert meters to kilometers, divide meters by 1000 (not by 10). Record your slide measurements in kilometers in the column marked "km" of Table 5-1.

5. Can you divide millimeter figures by 100 to

change directly to decimeters?_____

6. Can you divide millimeter figures by 1000 to

change directly to meters?_____

7. What number do you divide by when changing

centimeters to meters?_____

8. As a review, to change

(a) mm to cm, divide by_____.

(b) mm to dm, divide by_____.

(c) mm to m, divide by_____.

(d) mm to km, divide by_____.

(e) cm to m, divide by_____.

(f) cm to km, divide by_____.

• Measure the length and width of your lab table or desk.

• Record these dimensions in meters in Table 5-2. Record your answers in decimals. If your desk or lab table measures 1 m plus 14 cm, record this measurement as 1.14 m. If it measures less than 1 m, such as 83 cm, record this measurement as 0.83 m. Because 1 m equals 100 cm, 83 cm is the same as 83/100 or 0.83 m.

• Convert your meter measurements to decimeters. Do this conversion by multiplying meter figures by 10. Record the decimeter values in the proper column of Table 5-2. Convert your decimeter values in Table 5-2 to centimeters. Do this conversion by multiplying decimeter figures by 10. Record the centimeter values in the proper column of Table 5-2.

TABLE 5-2. LAB TABLE MEASUREMENTS

	m	dm	cm	mm
Length				
Width				

9. What number is used to convert centimeter measurements to millimeters?_____

• To convert your centimeter values to millimeters, multiply centimeter figures by 10. Record the millimeter values in the proper column of Table 5-2.

10. According to Table 5-2, can you multiply meter figures by 100 to change directly to centimeters?_____

11. Can you multiply meter figures by 1000 to change directly to millimeters?_____

12. As a review, to change

(a) m to dm, multiply by_____.

(b) m to cm, multiply by_____.

(c) m to mm, multiply by_____.

Name _____

Date _____

(d) cm to mm, multiply by _____.

(e) km to m, multiply by _____.
(Be careful.)

• When converting from one SI unit to another, you must either multiply or divide. Is there any pattern which will always allow you to decide whether to divide or multiply? Yes, there is.

13. (a) What operation is used in Table 5-1 to go from millimeters to centimeters? (Millimeters are small in size, centimeters are larger units in size.) _____

(b) When changing from small SI units to large units, what mathematical operation (multiplying or dividing) is used? _____

14. Which unit is smaller in size:

(a) decimeter or meter? _____

(b) centimeter or kilometer? _____

(c) meter or kilometer? _____

15. (a) When changing from large SI units to smaller units, what mathematical operation (multiplying or dividing) is used? _____

(b) What operation is used in Table 5-2 to go from meters to centimeters? _____

16. Which unit is larger in size:

(a) kilometer or millimeter? _____

(b) decimeter or millimeter? _____

(c) centimeter or decimeter? _____

When changing from one unit to another, you must remember:

(a) If you are changing from a small unit to a larger unit, you must divide. What number to divide by is determined by what new units are being asked for. For example, if changing millimeters to centimeters, divide by 10; if changing millimeters to decimeters, divide by 100 again.

(b) if you are changing from a large unit to a smaller unit, you must multiply. What number to multiply by is determined by what new units are being asked for. For example, if changing kilometers to meters, multiply by 1000; changing meters to millimeters, multiply by 1000; changing kilometers to centimeters, multiply by 100 000.

The meter is the main unit for measuring length or distance in the SI system. All changes from one unit to another involve a change of 10, or some multiple of 10.

17. Fill in the blanks.

(a) 29 mm = _____ cm

(b) 4 dm = _____ m

(c) 44 dm = _____ cm

(d) 1205 cm = _____ dm

(e) 27 km = _____ m

18. Fill in the blanks.

(a) 103 dm = _____ m

(b) 0.29 dm = _____ mm

(c) 1202 mm = _____ cm

(d) 48 mm = _____ m

(e) 7.2 m = _____ cm

Part B. Measuring Volume in SI Units

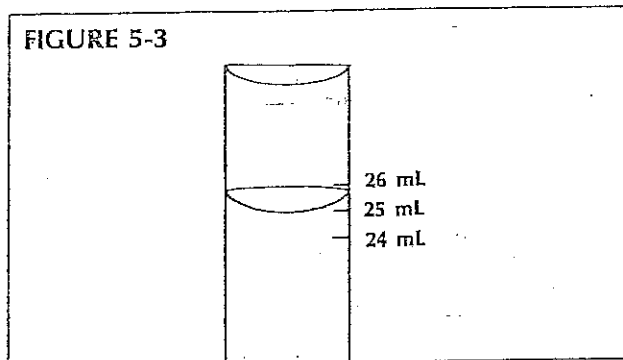
How much air do you inhale in one breath? How much water do you normally drink in one day? Can you measure the amount of space occupied by a bean seed? Getting answers to these questions involves the measuring of volume. What unit is used in the SI system to measure volume?

• Examine a graduated cylinder with volume markings of 50 units. Each single line represents a unit of volume called a milliliter (mL). DO NOT confuse this word with millimeter (mm).

• Fill the cylinder with water to the 25 mL line and place the cylinder on your desk.

• Compare the level of water in your cylinder with Figure 5-3. On close examination, the water rides up along the edges of the cylinder. The proper reading of volume is judged by the bottom level of water.

Adjust the volume of water if necessary so that it is exactly 25 mL. Convert your 25 mL volume to centiliter (cL) units. Use the same rule as established for length units. Are you changing from small to large units? If yes, then divide.



• Fill in Table 5-3 for centiliters, deciliters (dL), and liters (L). There are 10 centiliters in a deciliter, and 10 deciliters in a liter.

TABLE 5-3. VOLUME OF WATER IN CYLINDER				
	mL	cL	dL	L
Volume				

19. Complete the following chart based on the numbers filled in for you. "kL" stands for kiloliter.

	kL	L	dL	cL	mL
Volume	.032	32			

The liter (L) is the main unit for measuring volume in the SI system.

20. Fill in the blanks:

(a) 1.4 L = _____ mL

(b) 5520 mL = _____ cL

Analysis

1. What SI units studied can be used for measuring length? _____

2. What SI units studied can be used for measuring volume? _____

3. Why is it easier to convert meters to centimeters or millimeters than to convert miles to feet or inches? _____

4. Give the symbol for each of the following units.

millimeter = _____ kiloliter = _____ centimeter = _____ liter = _____

5. What units are represented by each of the following symbols?

dL = _____ km = _____ dm = _____ cL = _____

6. Circle the larger unit in each of the following pairs.

(a) kiloliter or liter (c) decimeter or millimeter (e) millimeter or kilometer

(b) centimeter or meter (d) centimeter or millimeter (f) centiliter or deciliter

7. Which mathematical process (multiplying or dividing) is used to change

(a) centiliters to liters? _____

(b) centiliters to deciliters? _____

(c) meters to centimeters? _____

(d) millimeters to meters? _____

Introduction to the Microscope Lab Activity

Introduction

"Micro" refers to tiny, "scope" refers to view or look at. Microscopes are tools used to enlarge images of small objects so as they can be studied. The compound light microscope is an instrument containing two lenses, which magnifies, and a variety of knobs to resolve (focus) the picture. Because it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to as being a light microscope. In this lab, we will learn about the proper use and handling of the microscope.

Instructional Objectives

- Demonstrate the proper procedures used in correctly using the compound light microscope.
- Prepare and use a wet mount.
- Determine the total magnification of the microscope.
- Explain how to properly handle the microscope.
- Describe changes in the field of view and available light when going from low to high power using the compound light microscope
- Explain why objects must be centered in the field of view before going from low to high power using the compound light microscope.
- Explain how to increase the amount of light when going from low to high power using the compound light microscope.
- Explain the proper procedure for focusing under low and high power using the compound light microscope.

Materials

- Compound microscope
- Glass slides
- Cover slips
- Eye dropper
- Beaker of water
- The letter "e" cut from newsprint
- Scissors

Procedures

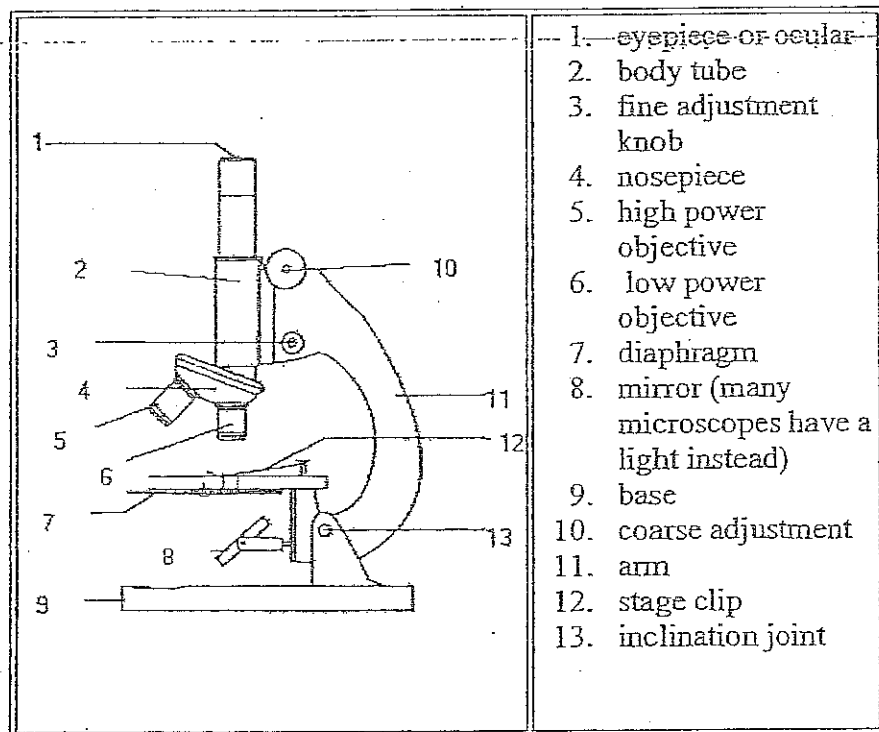
I. Microscope Handling

1. Carry the microscope with both hands — one on the arm and the other under the base of the microscope.
2. One person from each group will now go over to the microscope storage area and properly

Introduction to the Microscope Lab

transport one microscope to your working area.

3. The other person in the group will pick up a pair of scissors, newsprint, a slide, and a cover slip.
4. Remove the dust cover and store it properly. Plug in the scope. Do not turn it on until told to do so.
5. Examine the microscope and give the function of each of the parts listed on the right side of the diagram.



Names of parts and their functions (place these on a sheet attached to this report)

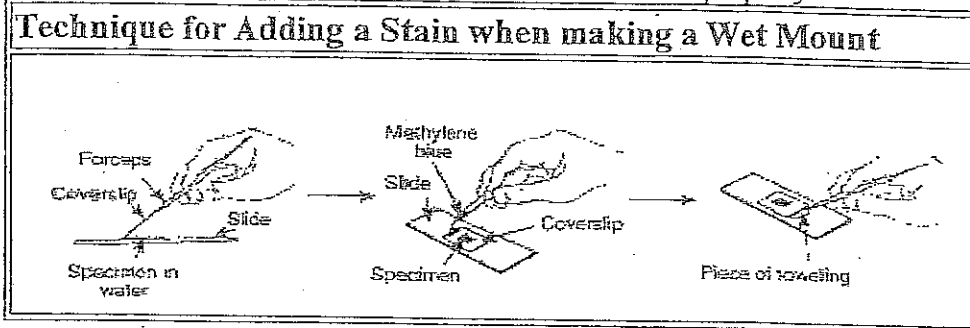
Part II. Preparing a wet mount of the letter "e".

1. With your scissors cut out the letter "e" from the newspaper.
2. Place it on the glass slide so as to look like (e).
3. Cover it with a clean cover slip. See the figure below.

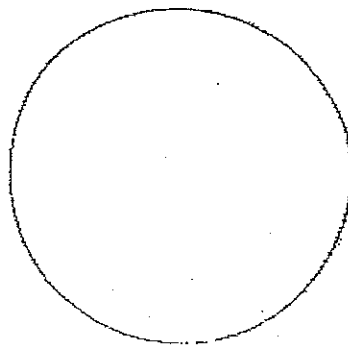


Introduction to the Microscope Lab

4. Using your eyedropper, place a drop of water on the edge of the cover slip where it touches the glass slide. The water should be sucked under the slide if done properly.



5. Turn on the microscope and place the slide on the stage; making sure the "e" is facing the normal reading position (see the figure above). Using the course focus and low power, move the body tube down until the "e" can be seen clearly. Draw what you see in the space below.



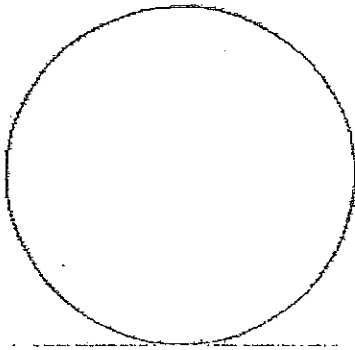
6. Describe the relationship between what you see through the eyepiece and what you see on the stage.

7. Looking through the eyepiece, move the slide to the upper right area of the stage. What direction does the image move?

8. Now, move it to the lower left side of the stage. What direction does the image move?

9. Re-center the slide and change the scope to high power. You will notice the "e" is out of focus. **Do Not** touch the coarse focus knob, instead use the fine focus to resolve the picture. Draw the image you see of the letter e (or part of it) on high power.

Introduction to the Microscope Lab



10. Locate the diaphragm under the stage. Move it and record the changes in light intensity as you do so.

III. Determining Total Magnification:

1. Locate the numbers on the eyepiece and the low power objective and fill in the blanks below.

Eyepiece magnification	(X)	Objective magnification	Total Magnification
			X

2. Do the same for the high power objective.

Eyepiece magnification	(X)	Objective magnification	Total Magnification
			X

3. Write out the rule for determining total magnification of a compound microscope.

4. Remove the slide and clean it up. Turn off the microscope and wind up the wire so it resembles its original position. Place the low power objective in place and lower the body tube. Cover the scope with the dust cover. Place the scope back in its original space in the cabinet.

Introduction to the Microscope Lab

Conclusion Questions:

1. State 2 procedures which should be used to properly handle a light microscope.
2. Explain why the light microscope is also called the compound microscope.
3. Images observed under the light microscope are reversed and inverted. Explain what this means.
4. Explain why the specimen must be centered in the field of view on low power before going to high power.
5. A microscope has a 20 X ocular (eyepiece) and two objectives of 10 X and 43 X respectively:
 - a.) Calculate the low power magnification of this microscope. Show your formula and all work.
 - b.) Calculate the high power magnification of this microscope. Show your formula and all work.
6. In three steps using complete sentences, describe how to make a proper wet mount of the letter e.
7. Describe the changes in the field of view and the amount of available light when going from low to high power using the compound microscope.
8. Explain what the microscope user may have to do to combat the problems incurred in question # 7.
9. How does the procedure for using the microscope differ under high power as opposed to low power?

Introduction to the Microscope Lab

10. Indicate and describe a major way the stereomicroscope differs from the compound light microscope in terms of its use.
-

NAME _____ DATE _____
 PARTNER _____ TEACHER _____

The Compound Microscope

BACKGROUND: The microscope is an important scientific tool. It enables a person to observe things too small to be seen with the unaided eye. In many of the activities you will do in Biology, you will use a *compound microscope*, a microscope having two lenses. In this type of microscope, light passes through the *specimen*, or object being viewed. One lens, the *objective*, causes the light rays coming from the specimen to spread apart, forming an enlarged image of the object. The second lens, the *ocular*, focuses and further enlarges the image.

Working with a compound microscope, you may use specimens that have been prepared in one of two ways. A prepared slide is made to be permanent and can be purchased from a supply house. A *wet-mount* slide is made for temporary use and can be made and used during a lab period.

OBJECTIVES: In this activity you will:

1. Learn the parts and operation of a compound microscope.
2. Learn to prepare and observe a wet mount.

MATERIALS:

microscope
slides
cover slips
lens paper
paper towels

water
pipette
scissors
ruler
leaves

dissecting needle
sheet of newspaper
magazine picture in color
hairs or threads of different color
pieces of very thin cloth

PROCEDURES AND OBSERVATIONS:

Part 1. Learning About the Microscope

1. Obtain your microscope from your teacher. Always carry the microscope in an upright position with one hand holding the arm and the other supporting the base, as shown in Figure 1. Set it down away from the edge of the table.

Note: The microscope is an expensive, precision instrument. Handle it carefully.

2. Compare your microscope with Figure 2 on the next page. Identify each part on your microscope.

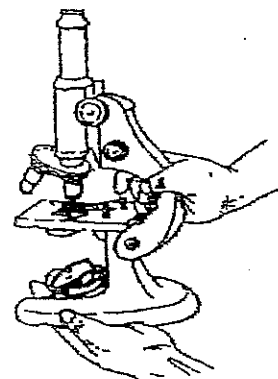


Figure 1

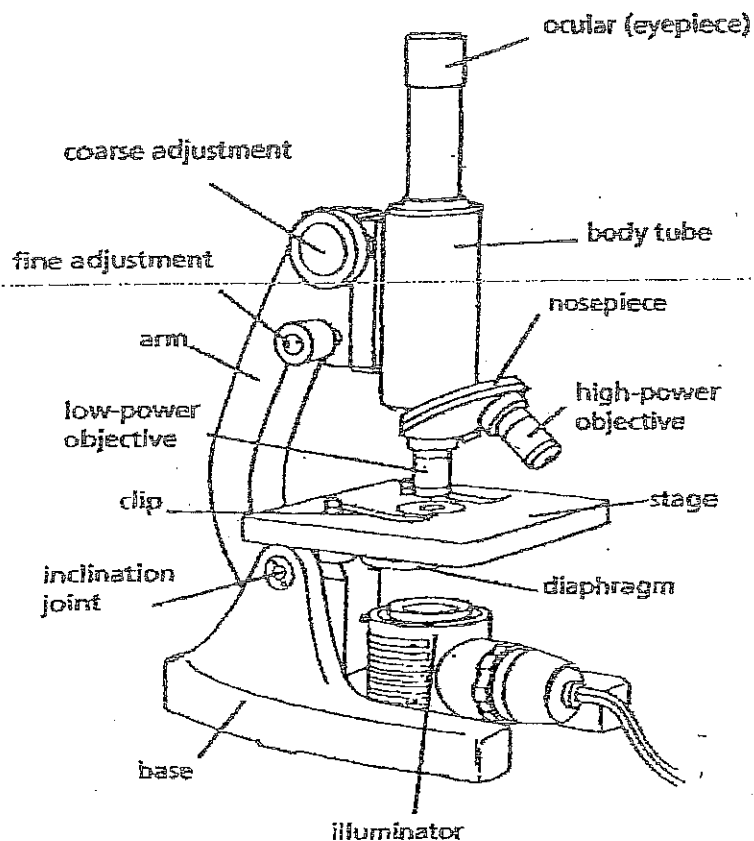


Figure 2

3. Some microscopes have a built-in electric light, or illuminator. Others have a mirror to reflect light onto the specimen. If you have a mirror, note that its angle is adjustable. Practice directing the reflected light upward through the microscope by slanting the face of the mirror. Look through the ocular as you adjust the mirror to obtain the maximum amount of light. **CAUTION: Never use direct sunlight as a light source. It can damage your eyes.**
4. Examine the diaphragm. Adjust it to the largest opening so that the most light enters the microscope. You can tell this by looking through the ocular.
5. While looking at your microscope from the side, slowly turn the coarse adjustment one-half turn toward you.

In which direction does the objective move? _____

6. Continue to turn the coarse adjustment until the low power objective is about 3 cm from the stage. The low power objective is the *second shortest* objective on a microscope with three objective lenses. The shortest objective is the scanning objective.

7. Look at the number followed by an "X" on the side of each objective. This number is the objective's magnifying power. The "X" stands for "times." Thus the number tells how many times an object is magnified by this lens.

What is the magnifying power of the low-power objective? _____

8. Locate the high-power objective, the longest of the three.

What is its magnifying power? _____

9. Determine the magnifying power of the lowest-power objective. _____



10. If the lenses look dirty or smudged, carefully wipe them with lens paper. Use only lens paper because other kinds of paper can damage the lenses.

The ocular lens also has a magnifying power. The total magnifying power of the microscope is easy to calculate. Simply multiply the magnifying power of the ocular by the magnifying power of the objective. For example, if the ocular is 5X and the objective is 10X, the total magnification of the object being viewed is $5X \times 10X = 50X$.

11. Examine the ocular lens. What is its magnifying power? _____

What is the total magnification produced when the low-power objective is used? Show your calculations.

What is the total magnification produced when the high-power objective is used? Show your calculations.

Part 2. Preparing and Examining a Wet Mount

1. Find a small letter "e" in a piece of newspaper. Cut a 1-cm square of paper with the "e" near the center.

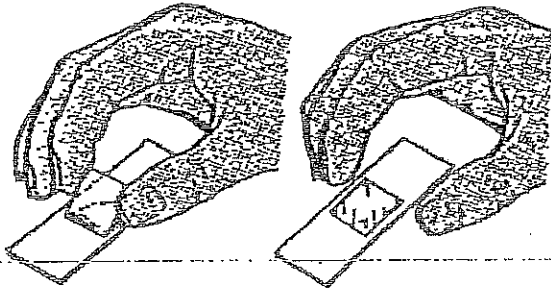


Figure 3-a

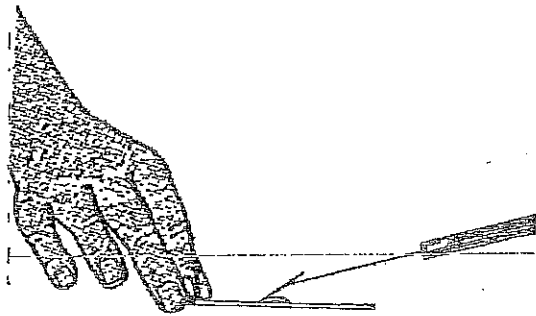


Figure 3-b

2. Place the square in the middle of a clean slide. With a pipette, put 1 drop of water on the square. Drop the water from about 1 cm above the slide. Do not touch the pipette to the paper or the paper will stick to the pipette.
3. Now cover the mount with a clean cover slip. One way to do this is shown in Figure 3-a. Hold the cover slip at about a 45° angle to the slide and move it toward the drop. As the water touches the cover slip, it will spread along the edge. Gently lower the cover slip into place. Another way to put the cover slip into place is to support the cover slip with a dissecting needle, as shown in Figure 3-b. Slowly lower the supported edge and watch as the water fills the space. Use whichever method is easier for you and gives you a good wet mount. Do not press on the cover slip — it should rest on the top of the water. A good wet mount is free of bubbles. If your mount has too many bubbles, take off the cover slip and absorb the water with a paper towel. Then repeat Steps 2 and 3.
4. Click the low-power objective into place. Make sure you have a good light source and that the diaphragm is at the largest opening. Look through the microscope and adjust the mirror or illuminator to give the brightest light. Remember to never use direct sunlight as a light source.
5. Check to be sure the bottom of the slide is dry before placing it on the stage of the microscope. Set it on the stage so that the "e" is in reading position and over the hole in the stage. Fasten the slide with stage clips.
6. Look at the microscope from the side. Use the coarse adjustment knob to lower the body tube until the objective is about 1/2 to 1 cm above the slide, or until you feel an automatic stop.
7. Look through the ocular, keeping both eyes open. Keeping both eyes open is difficult at first, but it helps to prevent eyestrain. It will become easier with practice. **Note:** Always look at the microscope from the side while you lower the low-power objective. If you look through the eyepiece you could run the objective into the slide, breaking the slide and damaging the microscope.



8. Slowly raise the objective by turning the coarse adjustment until the letters come into focus. Use the fine adjustment to sharpen the focus. Observe the letter "e."

On a separate piece of drawing paper, draw the letter "e" the same size and in exactly the same position as you see it through the microscope.

9. Move the slide to the left. Which way does the image move? _____

10. Move the slide to the right. Which way does the image move? _____

11. Move the slide backward and forward. Which ways does the image move? _____

12. Observe the wet mount as you change the diaphragm to each of its settings. Adjust it to give good contrast and illumination without glare.

What does the diaphragm control? _____

Before using high power, the specimen must be in sharp focus in the center of the low-power field of view. Try to center your "e" so that a sharp edge between black and white is centered in your field of view. Note: *All focusing under high power is done with the fine adjustment knobs.* There is no automatic stop for the high-power objective.



13. Watching from the side, carefully switch to the high-power objective. Make sure that the objective does not hit the slide, but expect it to be very close.

14. Focus on the letter "e." Only a slight turn of the fine adjustment knob will be needed to do this.

On a separate piece of drawing paper, draw the letter "e" exactly as you see it under high power.

Is the field of view larger under high power or low power? _____

Compare the brightness of the field under high power and low power.

Part 3: Resolving Power and Depth of Field

1. Make a wet mount using a 1-cm square of a colored newspaper cartoon or a colored picture from a magazine printed on thin paper. Choose a square that has both light and dark tones, but not black.

Record the colors of the square visible to your unaided eye.

Resolving power is the ability to distinguish between two separate points that are very close together. Microscopes have a resolving power greater than that of the human eye.

2. Observe the slide under low power. Then switch to high power. Examine the light and dark areas of the square.

How is the color distributed? _____

What colors do you see? _____

The *depth of field* is the distance above the slide in which the object is in good focus.

3. Prepare another wet mount, this time using two hairs or threads of different colors. Cross them on the slide, then add a drop of water and the cover slip.

4. View the slide under low power. Focus directly on the point where the hairs cross.

Are both hairs in focus under low power? _____

5. Switch to high power and observe the hairs.

Are both hairs in focus under high power? Explain your observation.



6. Prepare some wet mounts of other things, such as pieces of cloth, skin, a fly's wing, or anything that is thin enough for light to pass through it.

Sketch the things that you observe under the microscope on a separate piece of drawing paper. Label each drawing with its name and the magnification used.

Part 4: Comparing the Stereomicroscope to the Compound Microscope

1. Look at the stereomicroscope and determine how its uses differ from the compound microscope.

Which microscope is larger? _____

2. Put a part of a plant on a paper towel and put it on the stage of the stereomicroscope. Move the paper towel to the left. If you move an object to the left under a compound light microscope, it appears to move to the right.

In what direction did the plant appear to move under the stereomicroscope?

Is this the same as, or different from, the compound light microscope?

3. Observe the working distance (space between the objective and the stage) for the stereomicroscope.

How does this compare to the compound light microscope? _____

How does this affect the size of objects that can be viewed under the stereomicroscope? _____

4. Compound light microscopes work by having light pass through the objects to be viewed. However, not all objects are translucent.

If an opaque object is viewed through a compound light microscope, what will you see? _____

5. Place a leaf under the stereomicroscope. Shine a strong light on it.



How does this way of lighting an object allow you to observe objects that

cannot be viewed under a compound light microscope? _____

6. Make a sketch of the leaf and one other object as seen under the stereomicroscope.

ANALYSIS:

1. Demonstrate your familiarity with the parts of the microscope by completing the chart below.

Part	Function
Ocular	
Coarse adjustment	
Nosepiece	
Objectives	
Stage	
Stage clips	
Diaphragm	

Mirror or illuminator	
Fine adjustment	

2. Why should a wet mount have no bubbles?
3. What did the microscope do to the image of the letter "e"?
4. Why must you center and focus the object in the field of view under low power before switching to high power?
5. Why is only the fine adjustment used for high power?
6. Explain why the color of the magazine picture looked different when you looked at it under the microscope?
7. By using the idea of depth of field, how can you tell which hair was above the other?
8. If you were scanning a slide to find a particular area, which objective would be better to use? Why?
9. Why do you think things look three dimensional under the stereomicroscope?
10. Under what circumstances would you use a stereomicroscope instead of a compound light microscope?

CONCLUSION:

Suppose you wanted to view a spider's web under the microscope. Describe fully the procedure you would use to prepare the specimen and view it.

Name _____ Period _____ Date _____

Measurement with the Microscope

Background:

It is interesting and informative to observe specimens under the microscope, but it is often difficult to determine the actual size of the object strictly by observing it. Since you cannot hold a ruler under a slide or a moving object to measure its size, you must figure it out indirectly. By figuring out the diameter of the microscope ahead of time, that information can be used to figure out the sizes of the various microscopic items we will observe this year.

Keep this measurement in mind:

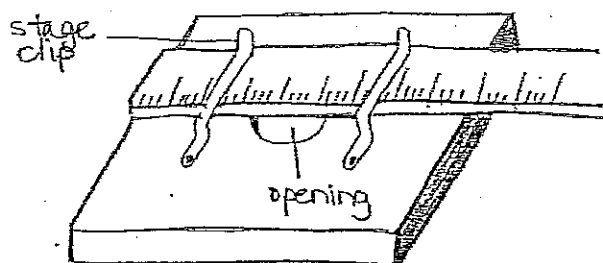
1 millimeter (mm) = 1,000 micrometers (um)

Materials:

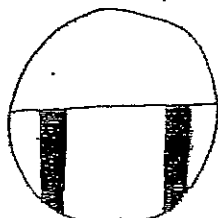
- ❖ Microscope
- ❖ Transparent metric ruler
- ❖ Prepared slide of a paramecium
- ❖ Prepared slide of the cross section of a corn stem

Procedures:

- 1) Examine the markings on a transparent metric ruler. Determine which marks indicate millimeter lengths. Then place the ruler on the stage so that it covers half of the stage opening as shown below.



- 2) Switch the objective lens to medium power (10x)
- 3) Look through the ocular (eyepiece). Focus on the edge of the ruler, using the coarse adjustment. Adjust the position of the ruler so that the view in the low power field is similar to the one below



- 4) Place the center of one mark all the way to the left side of the field of view. Make sure that the edge of the ruler is exactly across the center of the field.

- 5) Note that 1 millimeter is the distance from the middle of one mark to the middle of the next mark.
- Using the ruler, determine the measurement of the low-power field diameter in millimeters. Express your answer to the nearest tenth of a millimeter.

- 6) Now convert that measurement to micrometers
- _____
- 7) The measurement of the low-power diameter can now be used as a reference point for estimating the diameter of other objects and organisms.
- 8) Under low power, focus on a prepared cross-section of corn stem. The center of a corn stem is filled with large, thin-walled cells. These are called *pith cells*.
- 9) Observe the pith cells.
- How many pith cells can you estimate will fit from one end to the other across your field of view?

 - Now, based on your measurements, how large is one pith cell in micrometers? Be sure to SHOW YOUR WORK FOR THIS CALCULATION

- 10) Now switch the slide to the prepared slide of the paramecium. Even though they are scattered throughout the slide, try to estimate how many paramecium could fit end to end across the diameter of the microscope.
- How many do you think will fit? _____
 - So, how large is one paramecium in micrometers? Be sure to SHOW YOUR WORK FOR THIS CALCULATION

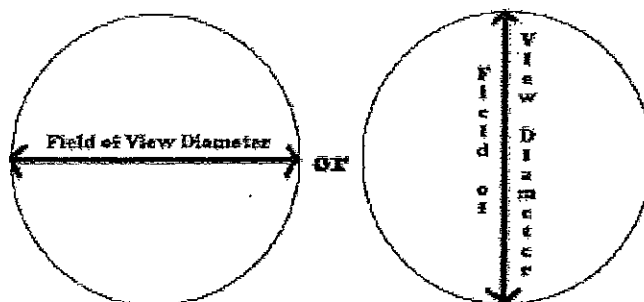
Analysis:

- 11) Why do you think it is so important for scientists to be able to measure items under the microscope?
- _____
- _____
- _____
- 12) How is the need to estimate a limitation to the work of a scientist using a microscope?
- _____
- _____
- _____

Name: _____ Class: _____ Date: _____

Measuring with a Microscope Lab

Background: Even though it can be interesting and informative to observe specimens under the microscope, it is often difficult to know the actual size of the object you are looking at. You can not just hold a ruler up to a paramecium or plant cell to determine its size. Therefore, size must be measured indirectly, or compared to the size of something you already know. A convenient standard to use is the *field of view diameter* in a compound light microscope



Two metric units that will be useful for this and all future microscope activities are the *millimeter* (mm) and *micrometer* (μm) (*The micro symbol ' μ ' looks like a 'u' with a longer tail in the front)

1 meter (m) = 1000 millimeters (mm)
1 millimeter (mm) = 1000 micrometers (μm)

m = 10^0	or	1m
mm = 10^{-3}	or	0.001m
$\mu\text{m} = 10^{-6}$	or	0.000001m

Objectives: in this activity you will:

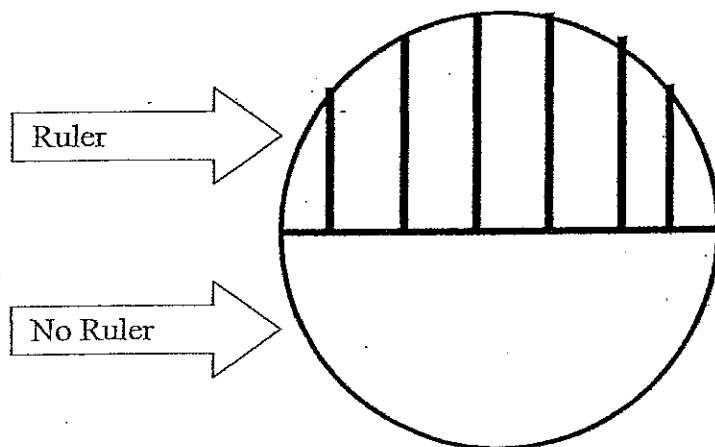
1. Measure the field of view diameter in the low and medium power fields
2. Calculate the field of view diameter in the high-power field
3. Estimate the sizes of objects viewed under the microscope

Materials:

- Microscope
- Transparent ruler (ONLY USE METRIC (mm)...no inches please)
- Prepared slides of onion cells
- Pencil for drawing structures

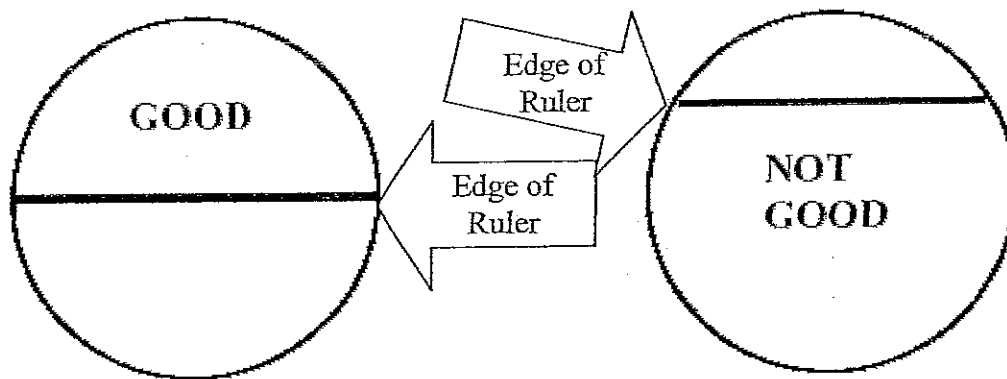
Procedure:

- 14.
- 1) Take the cover off the microscope and turn it on.
 - 2) Start on the 4X objective lens. (40X total magnification)
 - 3) Put the ruler on the stage so that it covers half of what you see in the microscope so you can see the markings like the following diagram:



- 4) Look through the ocular lens and focus on the ruler until it becomes clear. Use the coarse adjustment knob to do this.
- 5) Make sure the edge of your ruler is across the middle of the view in the microscope so you can get the most accurate diameter measurement.

Examples of the right and wrong way to place the ruler:



- 6) Figure out the diameter by counting how many millimeters go across the middle of the field of view.

6a. Diameter to the nearest tenth = _____ mm

6b. Convert this to micrometers by multiplying that number by 1000 =
_____ μm

- 7) Switch to the 10X objective (100X total magnification).
- 8) Make sure the edge of the ruler is still in the middle of field of view.
- 9) Use the fine adjustment knob to focus until the ruler is clear again.
- 10) Figure out the diameter by counting how many millimeters go across the middle of the field of view.
 - 10a. Diameter to the nearest tenth = _____ mm
 - 10b. Convert this to micrometers by multiplying that number by 1000 =
_____ μm
- 11) You will **not** be able to measure field of view diameter in the high-power field using the same process as you have just completed. Focusing and light problems exists and you may actually hit the ruler with the objective lens. The diameter is less than 1mm and will not easily be seen.
- 12) You can obtain the diameter indirectly using certain values obtained in earlier procedures with the help of a mathematical formula. The key idea to remember it that *magnification is inversely proportional to field of view*.

13) Calculate the "High Power Field of View" using the following formula:

$$\frac{\text{High Power Field of View}}{\text{Medium Power Field of View}} = \frac{\text{Medium Power Magnification}}{\text{High Power Magnification}}$$

Solve for X:

$$\frac{X}{\text{The answer from 10b}} = \frac{100}{400}$$

$$\frac{X}{\quad} = \frac{100}{400}$$

$$\frac{\quad}{\quad} = \frac{\quad}{\quad}$$

$$X = \quad \mu\text{m}$$

- 14) Turn the nosepiece to the 4X objective, put the prepared onion slide on the stage and focus with the course adjustment knob.

- 56.
- 15) Turn to medium power (10 X objective), and focus on a prepared cross section of the onion slide.
 - 16) You should see blue colored squares, which are the onion cells.
 - 17) Observe the cells and count how many fit across the diameter (middle) of the field of view.
 - 16a. Amount of cells in a line from one side to the other = _____
 - 16b. Calculate the length of the cells by dividing the answer from 10b by the answer from 16a using the following formula:

$$\frac{\text{Answer from 10b}}{\text{Answer from 16a}} = \frac{\quad}{\quad} = \quad \mu\text{m}$$

- 18) Switch to high power (40X) and focus with the fine adjustment knob.
- 19) Observe the cells and count how many fit across the diameter field of view.
 - 19a. Amount of cells in line from one side to the other = _____
 - 19b. Calculate the length of the cells by dividing the answer from #13 by the answer from 19a using the following formula:

$$\frac{\text{Answer from 13}}{\text{Answer from 19a}} = \frac{\quad}{\quad} = \quad \mu\text{m}$$

- 20) Compare your answers from 19b and 16b.
-
-

Analysis Questions:

1. Look at your measurement for the cells under medium power and the calculated measurement under high power. If measurements of the same object are different, what could be the reason? _____

2. I have a microscope with an ocular of 10X, a medium power objective of 10X, a medium power field of view diameter of 1600 micrometers and a high power objective of 40X.
 - a. What is the high power field of view diameter? Show all work...Hint, use the formula from within the lab (#13). = _____ μm

Name _____

Date _____

The Basic Unit Of Life

9

When different types of cells are viewed under a microscope, different cell parts can be seen. Certain living cells are best for showing parts like a nucleus or cell membrane. Once living (preserved) cells are best for showing parts like a cell wall. Cells from producer organisms (plants) will show parts such as chloroplasts and cell walls. Most consumer organism cells do not have these parts, although fungi have cell walls. We will not consider fungi in this investigation.

In this investigation, you will

- observe a variety of living and once living materials under the microscope.
- determine if these materials do or do not show a cellular type of organization.
- study and locate under the microscope six specific cell parts—cell wall, cell membrane, cytoplasm, nucleus, nucleolus and chloroplasts.
- compare the cell parts found in plant and animal cells.

Materials



microscope
microscope slides
coverslips
water
cork
razor blade (single-edge)
iodine stain
toothpicks
dropper
saxophone reed
methylene blue stain
onion bulb
Elodea (water plant)
frog blood, prepared slide

Procedure

Part A. The Cell Wall

Cork cells are excellent for studying a cell part common to all plant cells. This part is the cell wall. In a cork cell, the cell wall is easily visible. The cork is no longer living. The cell wall remains as the only evidence of once living materials.

- Use a razor blade to slice off a very thin section of cork using Figure 9-1 as a guide. Note that the slice should be made from the side of the cork, not its top or bottom. The slice must be tissue paper thin. Shavings of cork are ideal size. **CAUTION:** *Slice away from your fingers, not toward them, to avoid cuts.*

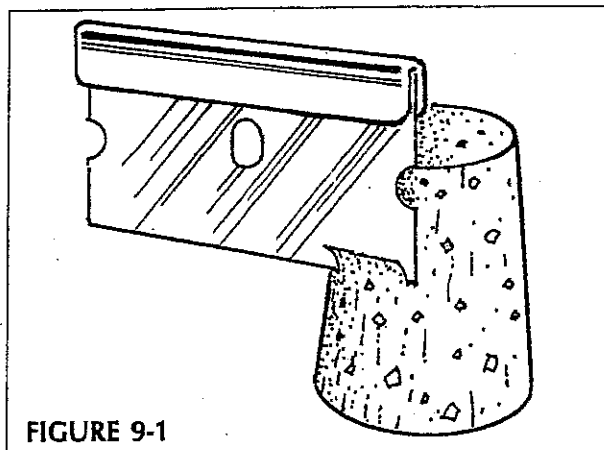
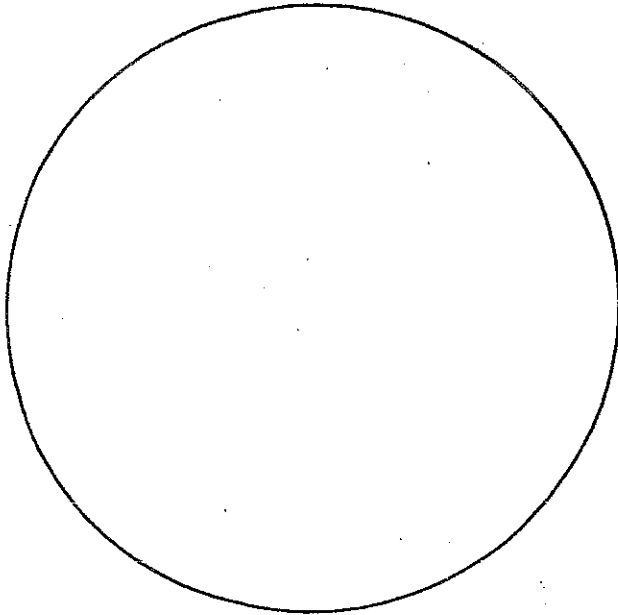


FIGURE 9-1

- Prepare a wet mount of your cork slice.
- Examine the cork under low power and then high power of your microscope. Use the fine adjustment to obtain a three-dimensional view of the cells.
- Use the space below to draw several cork cells as they appear under high magnification. Label *cell wall*.

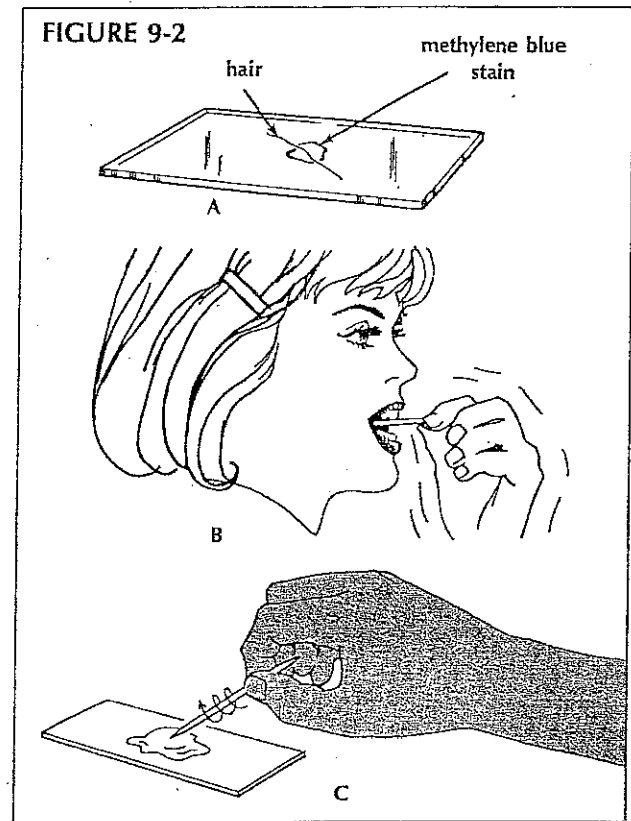


cork cells

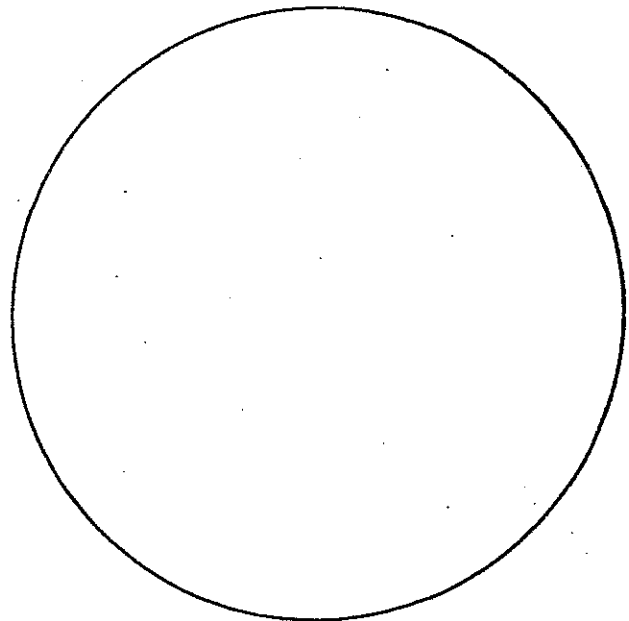
Part B. Cell Membrane and Cytoplasm

Human cheek cells may be used for viewing the cell membrane and cytoplasm. A cell membrane is a thin outer boundary which surrounds the cell and separates it from neighboring cells. Cytoplasm is the jellylike inner portion of the cell.

- Place a drop of methylene blue stain and a strand of hair onto a slide. Use Figure 9-2A as a guide.
- Gently scrape the *inside* of your cheek with the end of a toothpick. You will not be able to see anything on the toothpick when you remove it from your mouth (Figure 9-2B).
- Dip the toothpick into the stain on the slide and mix once or twice (Figure 9-2C).
- Add a coverslip and examine under low and high power of your microscope. (Use the hair as an aid in locating the proper depth for the cells.)



- Locate and examine cells that are separated from one another rather than those that are in clumps.
- Use the space below to draw several cheek cells as they appear under high magnification. Label the *cell membrane* and *cytoplasm*.



cheek cells

Name _____

Date _____

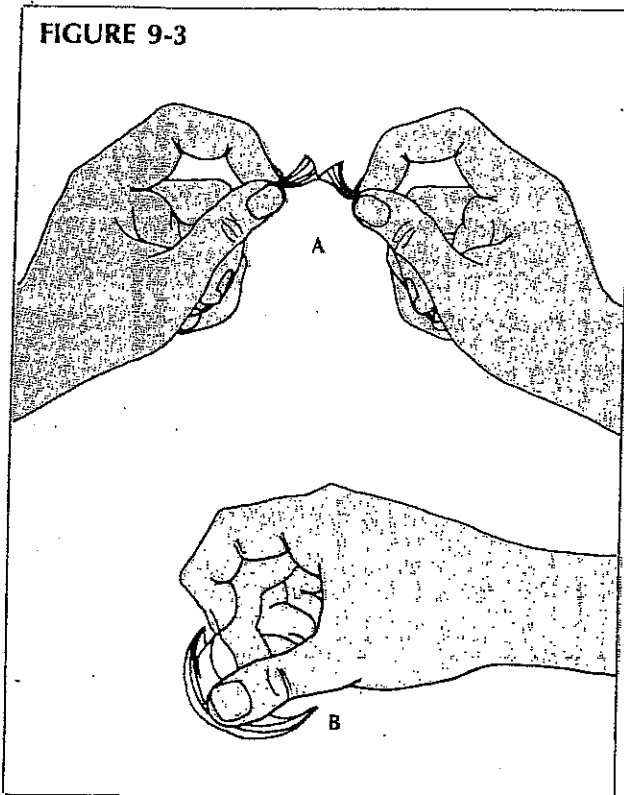
Part C. Cell Nucleus and Nucleolus

Onion cells may be used to show a cell's nucleus and nucleolus. These two structures appear within most living cells. There may be several nucleoli (plural of nucleolus) appearing as tiny dots within each cell's nucleus. The nucleus will appear as a round structure inside each cell.

Follow these steps in preparing onion cells for your wet mount:

- Snap an onion bulb scale (part of the onion you eat) in half (Figure 9-3A).
- Use your fingernail to peel off a thin layer of onion tissue (Figure 9-3B).
- Place one thin onion layer onto a microscope slide.
- Uncurl or unfold any overlapped portion of the cell layer. Make sure the layer is perfectly flat. Add a drop or two of iodine stain to the onion. **CAUTION: If iodine spillage occurs, rinse with water and call your teacher immediately.** Add a coverslip to the stained onion. Tap the coverslip gently with the eraser end of a pencil to drive out any air bubbles.

FIGURE 9-3



- Observe the cells under both low and high power of your microscope. Note the brick wall appearance of the cells with cell walls separating the cells.

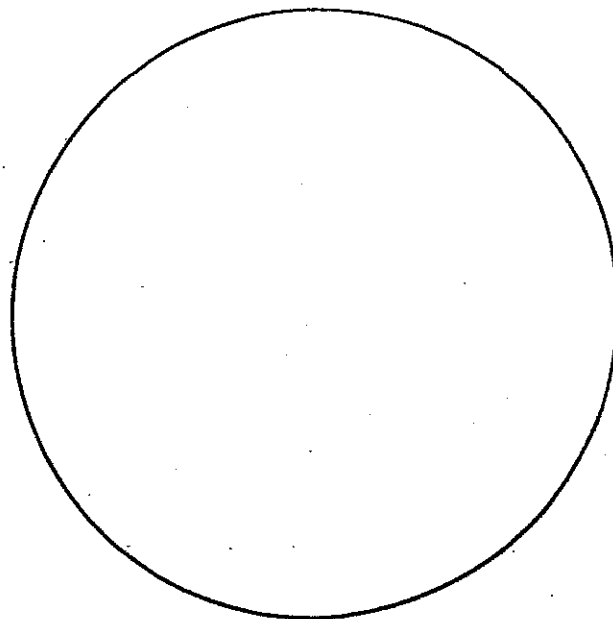
- Locate a small round structure, the nucleus, within each cell. Examine a nucleus carefully by focusing up and down through the cell.

- With high power, observe the tiny dots or eyelike structures within the nucleus. These are nucleoli.

The outer edge of the nucleus is made up of a thin covering called the nuclear membrane.

- Diagram a single onion cell in the space provided as it appears under high power.

- Label the *cell wall*, *nucleus*, *nucleolus*, and *nuclear membrane*.

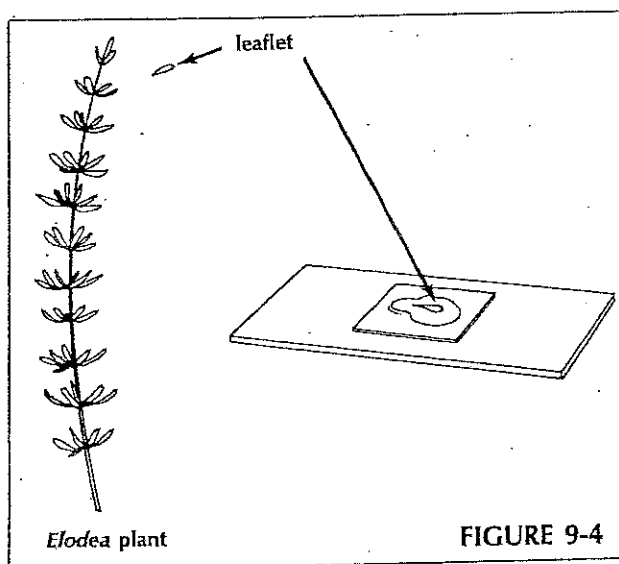


onion cell

Part D. Chloroplasts

Another cell part found in the cells of many producers is the green chloroplast. *Elodea*, a common water plant, shows these important structures well.

- Prepare a wet mount of an *Elodea* leaflet. Use Figure 9-4 as a guide.

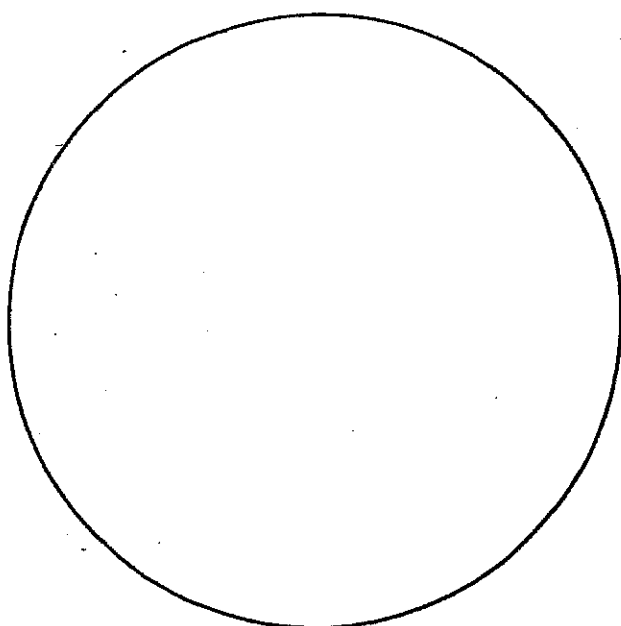


- Using low power of your microscope, position your slide so you are looking near the edge of the leaflet. Locate green, oblong cells. Examine these cells under high power.

- Note the small green organelles inside each cell. These are chloroplasts. Movement of the chloroplasts within the cell often can be observed. Attempt to locate moving chloroplasts.

- Diagram a single *Elodea* cell in the space provided. Use high power.

- Label *cell wall* and *chloroplast*.



Elodea cell

Part E. Plant or Animal Cell?

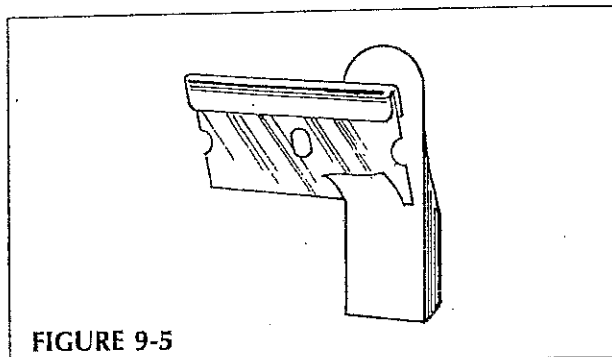
Bamboo Stem

- Prepare a wet mount of bamboo stem cells by using the following steps:

- (a) Hold a razor blade against the flat side of a reed (Figure 9-5).

- (b) Carefully cut away from your fingers and remove as thin a slice as possible from the reed.

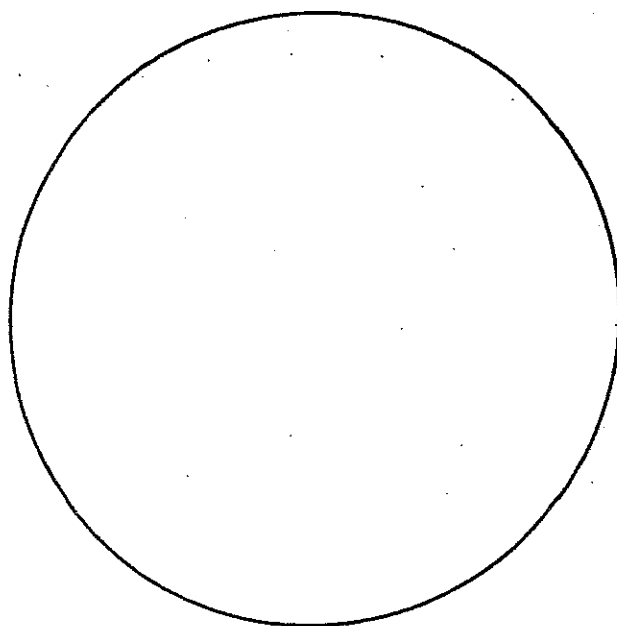
- (c) Place this thin slice on a slide in a drop of water. Add a coverslip.



- Observe the bamboo stem under low power.

- Diagram several bamboo cells in the space provided.

- Label the *cell wall*, *cytoplasm*, and *nucleus* only if these parts are present.



bamboo cells

Name _____

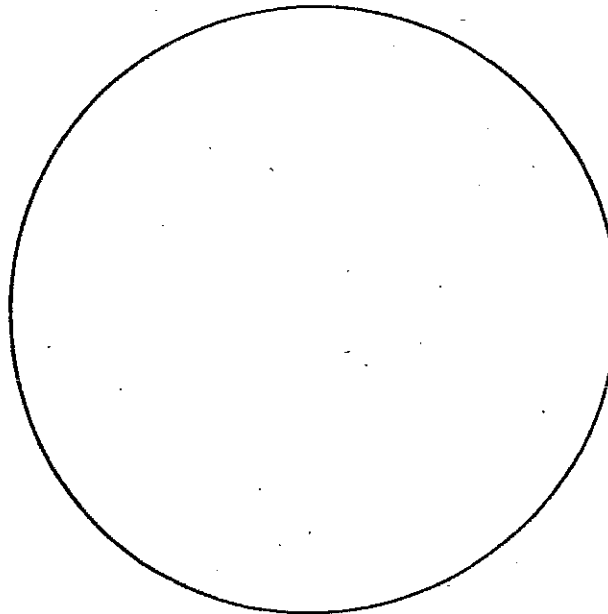
Date _____

Frog Blood

• Observe a prepared slide of frog blood. Use low and high power. The colors you see are not natural. Stains have been added to these cells to make viewing easier.

• Diagram several frog blood cells in the space provided. Use high power.

• Label the *cell wall*, *cell membrane*, *cytoplasm*, and *nucleus* only if these parts are present.



frog blood cells

Analysis**Analysis, Part A:**

1. Is the cork you used alive? _____
2. What are the small units that can be seen under high power called? _____
3. Do these units appear filled or empty? _____
4. What specific cell part is all that remains of the cell? _____
5. In 1665, Robert Hooke, an English scientist, reported an interesting observation while looking through his microscope at cork. "I took a good clear piece of cork, and with a penknife sharpened as keen as a razor, I cut a piece of it off, then examining it with a microscope, me thought I could perceive it to appear a little porous, much like a honeycomb, but that the pores were not regular."
 - (a) What were the honeycomb units at which Hooke was looking? _____
 - (b) What specific cell part was all that was left of the cork? _____
6. (a) Is cork produced by a plant or an animal? _____
 - (b) Do animal cells have cell walls? (NOTE: See introduction.) _____
7. Use your text to determine the name of the chemical which makes up the cell wall. _____

2.

Analysis, Part B:

1. Describe the shape of a cheek cell. _____
2. (a) Are cheek cells produced by plants or animals? _____
(b) Is a cell wall present? _____
3. Are cheek cells alive? _____
4. Describe the location of the cell membrane. _____
5. Use your text to determine the function of the cell membrane. _____

6. (a) Describe the location of the cell's cytoplasm. _____
(b) Describe the appearance of cytoplasm. _____
7. Use your text to determine the function of a cell's cytoplasm. _____

8. Why was a stain added to the cheek cells? _____
9. Do you have evidence that living things (or once living things) are composed of basic units called cells?
_____ Explain. _____

Analysis, Part C:

1. Describe the shape of an onion cell. _____
2. (a) Are onion cells produced by plants or animals? _____
(b) Is a cell wall present? _____
3. (a) Describe the shape of the nucleus of an onion cell. _____
(b) Within what cell part already studied does the nucleus lie? _____
4. What is the function of a cell's nucleus? (Consult text if necessary.) _____
5. (a) Describe the shape of the nucleolus of an onion cell. _____
(b) Where is the nucleolus found? _____
6. What is the function of a cell's nucleolus? (Consult your text if necessary.) _____

7. What structure separates the contents of the nucleus from the cytoplasm? _____
8. Why were the cells stained? _____

Name _____

Date _____

Analysis, Part D:

1. Describe the shape of an *Elodea* cell. _____
2. (a) Is elodea a plant or animal? _____
 (b) Is a cell wall present? _____
3. Describe the
 (a) color of the chloroplasts. _____
 (b) shape of the chloroplasts. _____
4. Within what cell part already studied do chloroplasts lie? _____
5. Use your text to determine the function of chloroplasts. _____
6. Are chloroplasts usually present in consumer cells? _____ Explain. _____

Analysis, Part E:

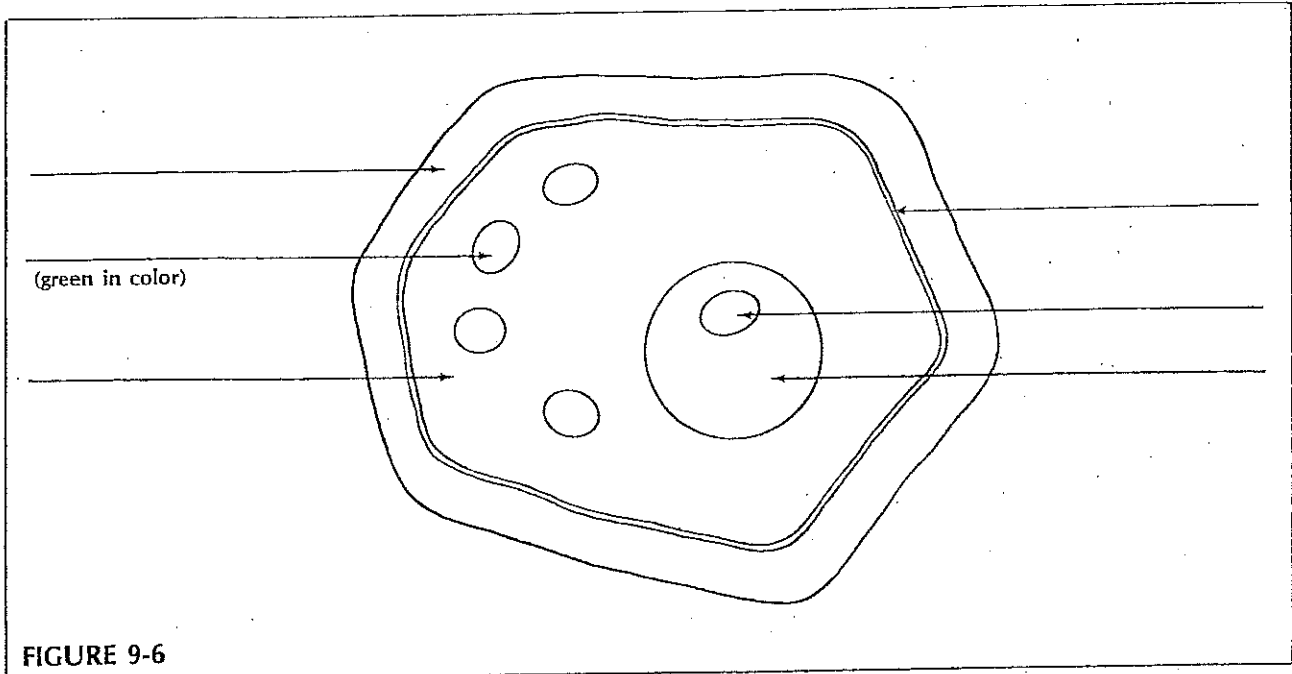
1. Describe the shape of bamboo cells. _____
2. (a) Can a cell wall be seen in bamboo? _____
 (b) Is bamboo a plant or animal? _____ Explain. _____
3. Describe the shape of frog blood cells. _____
4. (a) Can a cell wall be seen in frog blood cells? _____
 (b) Are blood cells from a producer or consumer? _____ Explain. _____
5. (a) What cell part name is used to describe the outer edge of a frog blood cell? _____
 (b) What cell part name is used to describe the dark center of a frog blood cell? _____

Analysis, General:

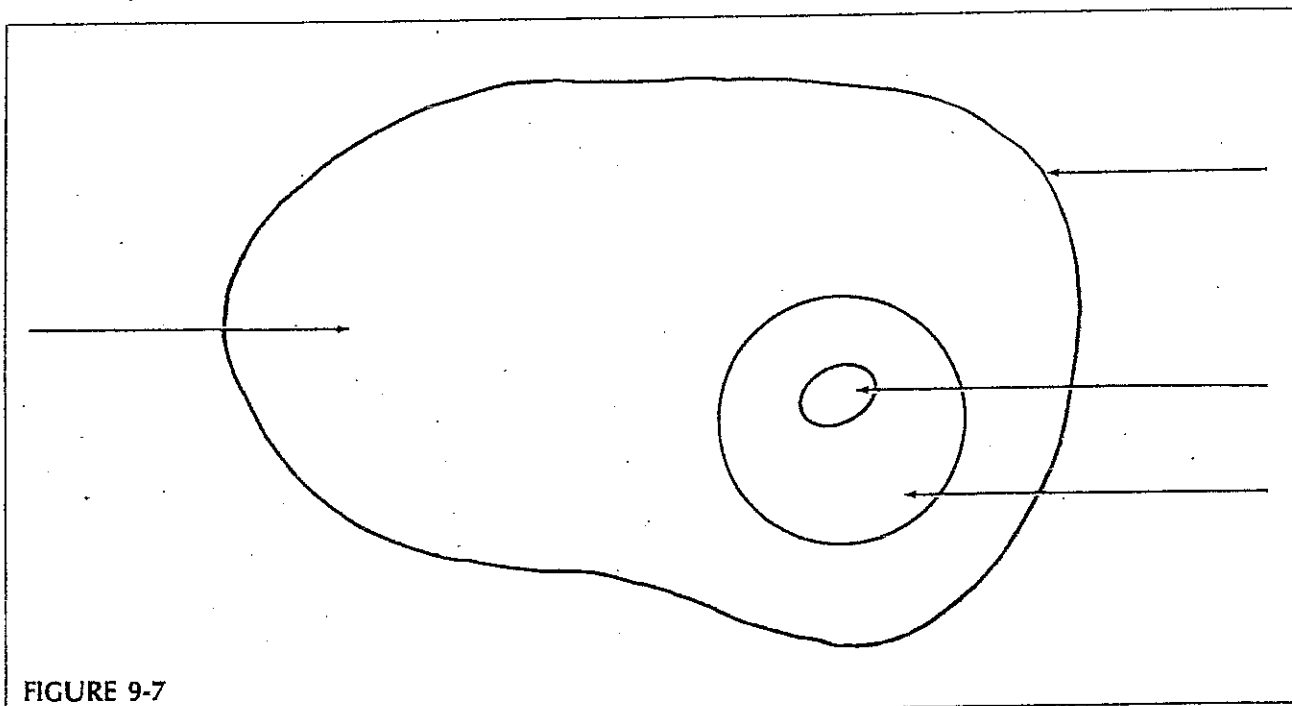
1. Complete this chart. Indicate by using check marks each structure contained in a plant or animal cell.

	NUCLEUS	CELL WALL	CYTOPLASM	NUCLEAR MEMBRANE	NUCLEOLUS	CHLOROPLASTS	CELL MEMBRANE
Animal Cell							
Plant Cell							

- 24
2. Complete Figure 9-6 of a "typical" plant cell. Use your text to determine where the following plant cell parts are located: *vacuoles*, *mitochondria*, *Golgi bodies*, *endoplasmic reticulum*, *ribosomes*, and *lysosomes*. Draw these parts as they would appear under an electron microscope onto Figure 9-6 and correctly label them. Label these parts which are already drawn for you: *cell wall*, *cytoplasm*, *cell membrane*, *chloroplast*, *nucleus*, *nucleolus*.



3. Complete Figure 9-7 of a "typical" animal cell. Label these parts which are already drawn for you: *cell membrane*, *nucleus*, *nucleolus*, *cytoplasm*. Use your text to determine where the following animal cell parts are located: *mitochondria*, *centrioles*, *Golgi bodies*, *endoplasmic reticulum*, *ribosomes*, and *lysosomes*. Draw these parts as they would appear under an electron microscope onto Figure 9-7 and correctly label them.



NAME _____ DATE _____
 PARTNER _____ TEACHER _____

How Plant and Animal Cells Differ

BACKGROUND: Although plant and animal cells have many structures in common, they also have basic differences. Plant cells have a rigid cell wall, and if they are green, they also have *chloroplasts*. Animal cells lack both a cell wall and chloroplasts. They also lack the central vacuole common to plant cells.

You will observe and compare animal cells and plant cells. You will first examine epithelial cells from the inside of your cheek. Epithelium is a type of tissue that covers the surfaces of many organs and cavities of the body.

You will then examine cells from a leaf of the freshwater plant elodea. Elodea is often used in home fish tanks. The cells of this plant are green because they contain the pigment, *chlorophyll*. Chlorophyll, which is found in chloroplasts within each cell, enables plants to manufacture their own food.

OBJECTIVES: In this activity you will:

- . Observe human epithelial cells.
- . Observe elodea cells.
- . Describe the differences between animal cells and plant cells.

MATERIALS:

microscope
 slides
 cover slips
 toothpick
 pipette

elodea
 forceps
 Lugol's iodine solution in dropper bottle
 methylene blue stain in dropper bottle
 water

PROCEDURES AND OBSERVATIONS:

Part 1. Human Epithelial Cells

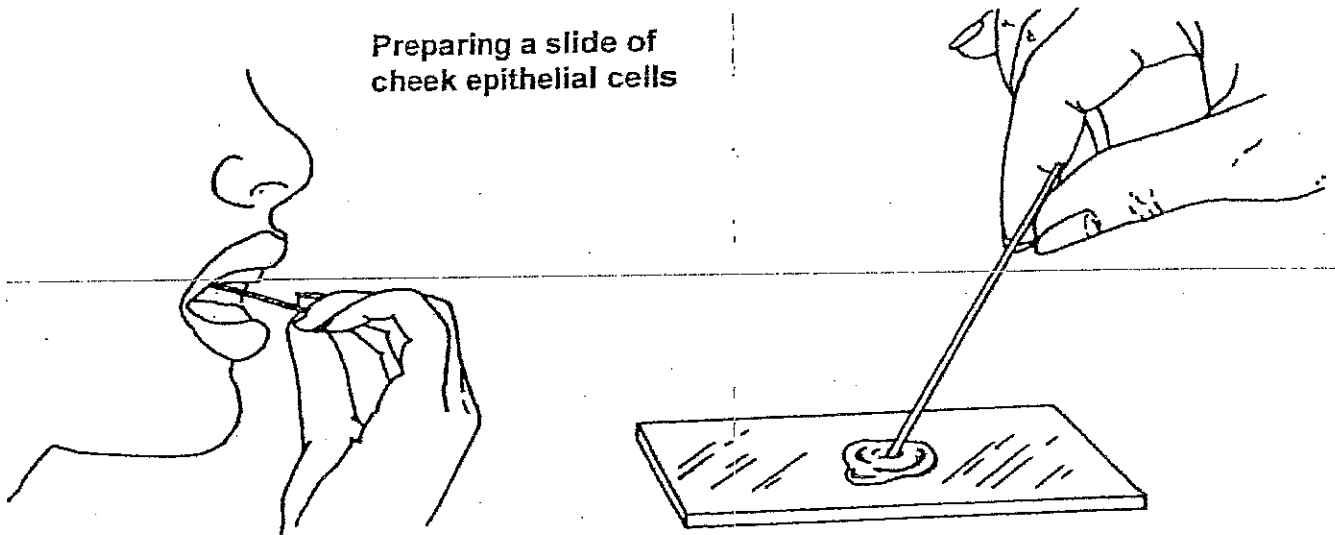
Place a drop of water on a clean slide. Obtain epithelial cells by gently scraping the inside of your cheek with a clean toothpick as shown in the diagram on the following page.



CAUTION: Never reuse a toothpick or put anything in your mouth which may not be clean.

Scrape the material from the toothpick in the drop of water on the slide. Then immediately break the toothpick in half and throw it away.

Preparing a slide of
cheek epithelial cells



2. Add a small drop of methylene blue stain to the slide.



CAUTION: *Stain can damage clothing and discolor skin.*

Use a clean toothpick to stir the cells on the slide, then immediately break the toothpick and throw it away. Carefully place a cover slip on the slide. Examine the slide under low power. When you find some cells that are separate from each other, examine them under high power. Recall that you may have to adjust the diaphragm to reduce the intensity of the light.



On a separate piece of drawing paper, make a drawing of two or three cells as they appear under high power. Label the *nucleus*, *nuclear membrane*, *cytoplasm*, and *cell membrane* of one of the cells.

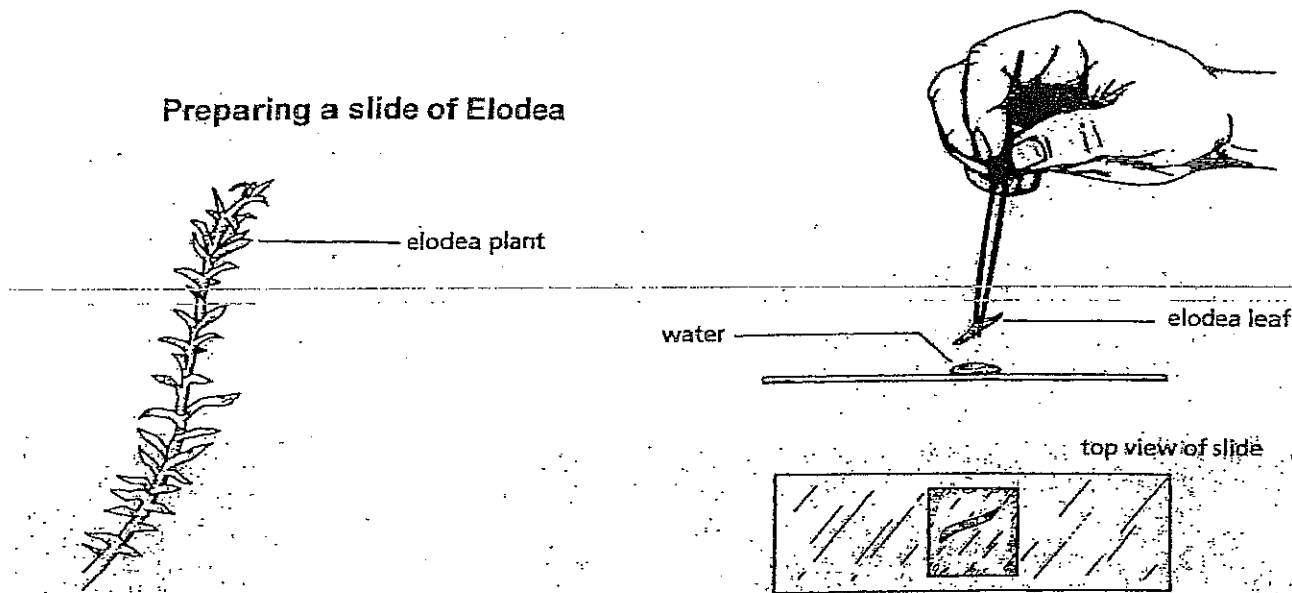
What is the shape of the cells? _____

Describe the appearance of the cytoplasm. _____

Part 2. Elodea Leaf Cells

1. Break off a small leaf near the tip of an elodea plant. With a forceps place the entire leaf in a drop of water on a clean slide as shown in the diagram on the following page. Add a cover slip.

Preparing a slide of Elodea



2. Examine the leaf under low power.

What is the shape of the cells? _____

The boundary that you see around each cell is the *cell wall*. The numerous small, green bodies in the cells are the *chloroplasts*.

3. Look for an area in the leaf where you can see the cells most clearly. Examine these cells under high power, carefully focusing up and down with the fine adjustment.

Describe the shape and location of the chloroplasts. _____

4. As you examine the cells, you may see the chloroplasts moving around. If they are not moving, warm the slide in your hand or under a bright lamp for a few minutes. Do not allow the slide to dry out. Then examine again under high power.

Describe how the chloroplasts move in a cell. _____

5. Make a drawing of an elodea cell. Label the *cell wall*, *chloroplasts*, and any other structures you see.

The cell membrane is pressed tightly against the inside of the cell wall and is difficult to see. Furthermore, the numerous chloroplasts often make it difficult to observe other cell structures in the elodea leaf cells. In order to see the nucleus, nucleoli, and vacuole more clearly, you are going to use a stain.

5. Break off another elodea leaf and place it in a drop of Lugol's iodine solution on a clean slide. Add a cover slip. Wait a minute or so for the stain to penetrate into the cells. Then examine the stained elodea cells under low and high power.



Make a drawing of a stained cell. Label the *cell wall*, *cell membrane* (if visible), *chloroplasts*, *nucleus*, *nucleolus*, and the *large vacuole*.

What structures can you see more clearly after staining? _____

ANALYSIS:

1. What structures do human epithelial cells have in common with elodea cells?
2. How do human epithelial cells and elodea cells differ?
3. Some of the epithelial cells are folded or wrinkled. What does this tell you about the thickness of the cells?
4. Chloroplasts cannot move on their own. How do you think they move around the cell?
5. What does Lugol's iodine stain do to the activity of the cell?

CONCLUSION:

What is the function of human cheek epithelial cells? How is the structure of these cells adapted to their function?

Name: _____
Living Environment

Date: _____
Period: _____

Diffusion Across a Membrane

In this investigation, you will determine whether different solutions are hypotonic, isotonic, or hypertonic relative to the inside of a chicken egg. The eggs have already been soaked in vinegar, which removes calcium from the shell. This allows the egg to act as a single cell encased in a selectively permeable membrane.

Problem: Are the tested solutions hypotonic, isotonic, or hypertonic to the egg? How will you be able to tell?

Hypothesis: _____

Procedure: (Day 1)

- 1) Remove eggs from the vinegar- be careful, it no longer has a hard shell.
- 2) Rinse eggs very briefly under running water- be sure to not allow the water to come out too hard, it could pierce the egg.
- 3) Empty container that contained vinegar and rinse it out.
- 4) Weigh container on triple beam balance and record mass in chart
- 5) Place egg gently back in container and weigh container
- 6) Determine weight of egg by subtracting the container weight from the total weight.
- 7) Choose two solutions you want to test in your experiment to determine whether they are hypotonic, isotonic, or hypertonic relative to the chicken egg. Select from:
 - Distilled water
 - 5% NaCl
 - 20% NaCl
 - 50% glucose solutions.
- 8) Pour solution over egg, just enough to cover egg.
- 9) Let sit overnight.

Procedure: (Day 2)

- 1) Remove eggs from the solutions- be careful, it no longer has a hard shell.
- 2) Rinse eggs very briefly under running water- be sure to not allow the water to come out too hard, it could pierce the egg.
- 3) Empty container that contained solution and rinse it out.
- 4) Place egg gently back in container and weigh container
- 5) Determine weight of egg by subtracting the container weight from the total weight.

Data Table:

	Egg 1	Egg 2
Solution Used		
Mass of Container		
Mass of Container + Egg (Day 1)		
Mass of egg (Day 1)		
Mass of Container + Egg (Day 2)		
Mass of egg (Day 2)		
Change in Mass of egg (Day 1 – Day 2)		
Isotonic/Hypotonic/Hypertonic?		

Recall: Red Blood Cells

- Draw what red blood cells look like in the boxes below
- Describe the movement of water- into or out of the cell?

	Isotonic	Hypotonic	Hypertonic
Red Blood Cell			
Direction of water movement?			

Analysis Questions: Answer on a separate sheet of paper in COMPLETE sentences.

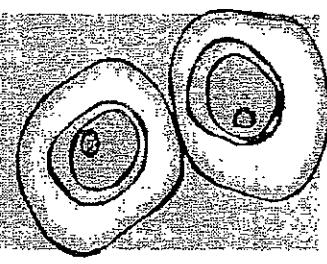
- 1) Define osmosis.
- 2) How is osmosis related to diffusion?
- 3) What were the dependent variable(s) in this lab?
- 4) What were the independent variable(s) in this lab?
- 5) Out of the solutions you tested, which were hypotonic, hypertonic, isotonic?
- 6) How were you able to determine which were hypotonic, hypertonic, isotonic?
- 7) How do the results of your eggs compare to what happens to red blood cells in hypotonic, hypertonic, and isotonic solutions?
- 8) Why do we get thirsty after eating a salty meal? What is happening in our blood?

Name _____ Period _____ Date _____

Laboratory Activity #5 — Student Laboratory Packet

Diffusion Through a Membrane

A Laboratory Activity for the Living Environment



Part 1—Diffusion Through a Membrane

Molecules are constantly moving. They move in straight lines unless they are deflected by other molecules or obstacles in their environment. *Diffusion* is the process by which the collisions between molecules cause them to continually spread apart from each other. Their overall movement can therefore be described as movement from an area of greater concentration to an area of lower concentration. Diffusion continues until the molecules are equally distributed, that is, their concentration is equal throughout the area that contains them. At this point, the molecules continue to move and collide, but their concentration remains the same throughout the area of containment.

When certain molecules encounter artificial membranes with pores, they may be able to pass through. If the molecules are small enough to pass through the pores, their movements eventually will cause the concentration of these molecules inside and outside of the membrane to equalize.

Living cells are surrounded by a membrane that acts as a selective barrier between the contents of the cell and its environment. The membrane is selectively permeable; it allows some molecules and other particles to enter and exit while blocking others. Even small molecules that could ordinarily pass through may be blocked. The permeability of the membrane can change depending on changes in the internal or external environment of the cell.

As a part of this activity, you will build a model cell using an artificial membrane. Remember that this membrane is only a model. Unlike a cell membrane, it will always have the same permeability to dissolved substances. Small molecules and water will be able to pass through easily while larger molecules will not.

Objectives

By the end of this activity, you should be able to:

- demonstrate how to test for simple sugars and starch using chemical indicators
- explain diffusion through a membrane
- describe the permeability of a model membrane for glucose, starch, and Starch Indicator Solution

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. You will also need to transfer your answers to a separate Student Answer Packet, which your teacher will use in grading your work. The school will retain that packet as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.



Materials

- dialysis tubing or plastic bags
- string or unwaxed dental floss
- Glucose Indicator Solution
- test tube rack
- concentrated glucose solution
- funnel
- tap water
- 7 test tubes
- starch solution
- paper towels
- droppers or pipettes
- safety goggles (1 pair per student)
- Starch Indicator Solution
- 250 mL beaker
- hot water bath (for class or several groups)
- test tube holder

Safety

- Avoid all direct contact with laboratory chemicals. The Glucose Indicator Solution is corrosive, and the Starch Indicator Solution will stain.
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Be careful when using the hot water bath to avoid burns.
- Wear goggles whenever someone in your laboratory is using glassware or chemicals.

Procedures: *Make a "Cell"*

The directions below are for making a "cell" with dialysis tubing. If you are using plastic bags, follow the directions your teacher provides.

1. Take a 20 cm length of dialysis tubing and soak it in warm tap water for a few minutes. You should then be able to pull the ends apart gently, forming it into a tube. Rubbing the ends of the tubing between your fingers under water is sometimes helpful when attempting to open the tube.
2. Seal one end of the tube by folding the end over and tying it closed with a piece of string or dental floss. The goal is to make that end completely leak-proof.
3. Pour glucose solution into the tube until it is about 1/4 full. Next, add enough starch solution to fill the tube about halfway. You can use a funnel to make this easier.
4. Tie off the top of the tube in the same way you tied off the bottom. The tube should not leak from either end. Gently mix the contents of the tube by turning it upside down and back again. Check for leaks.
5. Rinse off the "cell" you've just made by holding it under running water.
6. Place the "cell" in a beaker and add water until the "cell" is just covered.
7. Add Starch Indicator Solution (containing iodine) to the water in the beaker. Add enough to make the water an amber color.
8. Label the "Initial State" part of the diagram found on page 4. Indicate the contents and color of the beaker and cell.
9. Based on your knowledge of diffusion, predict what will happen to the substances inside and outside of the "cell." Record your prediction here:

10. Set the beaker aside while performing the chemical tests described in the next section of this investigation. Leave it undisturbed for at least 20 minutes.



Chemical Testing

Table One — Chemical Test Procedures

When Testing a Sample with	Follow This Procedure:
Starch Indicator Solution	<ul style="list-style-type: none"> • place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Starch Indicator Solution • carefully mix the contents of the tube • observe any color change • record results
Glucose Indicator Solution	<ul style="list-style-type: none"> • place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Glucose Indicator Solution • heat in a hot water bath for 2 minutes • observe any color change • record results

Procedure

- Obtain 6 clean test tubes and use them when testing samples of distilled water, starch, and glucose with each of the two indicator solutions. Follow the procedures described in Table One.
- Record your results in Table Two below. Enter the color observed in the test tube after each test is completed.

Table Two — Chemical Test Results

Indicator Solution Used	Material Tested		
	Distilled Water	Starch	Glucose
Blue-colored Glucose Indicator Solution			
Amber-colored Starch Indicator Solution			

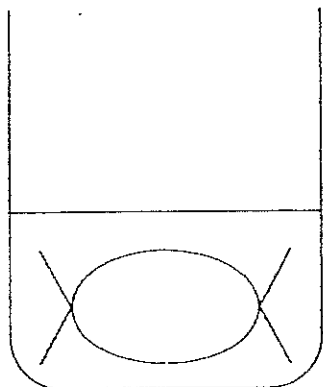
What test would you need to perform to prove that it is the *combination* of glucose and the Glucose Indicator Solution that changes color when heated and not just the glucose or the Glucose Indicator Solution alone? Support your answer with an explanation.



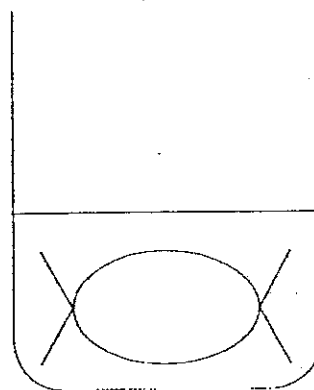
Model Cell Observations

- Carefully examine the "cell" and beaker you put aside earlier.
- Record any changes, including color changes, you observe in the "cell" and in the beaker.

- Use a pipette to transfer 10 drops of the solution in the beaker (outside the "cell") to a clean test tube. Test it with Glucose Indicator Solution. Did a color change occur? _____ Is this test result positive or negative? _____
- Label the contents and note the colors present in both the beaker and the cell of the "Final State" diagram below.



Initial State



Final State

- Clean up according to the directions given by your teacher.

Questions:

- What is the best explanation for the color change that occurred inside the "cell"? _____

- Did any starch diffuse out of the "cell"? _____ Explain how you can tell.

- Did any glucose diffuse out of the "cell"? _____ Explain how you can tell.

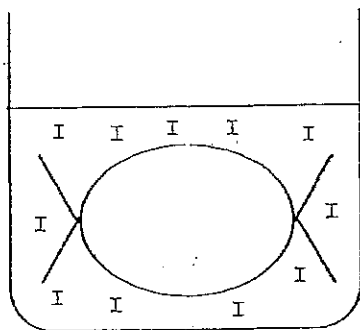


4. Which substance(s) diffused through the membrane?

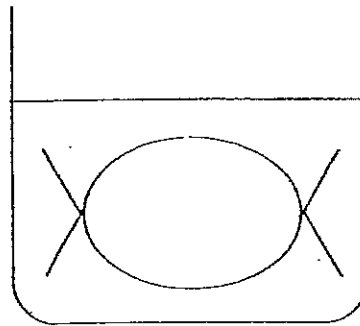
5. Which substance(s) did not diffuse through the membrane?

6. Explain why some substances were able to pass through the membrane while others were not able to.

7. In the "Initial State" diagram below, Starch Indicator Solution is indicated with the letter "I" because it contains iodine. Using the letters "S" for starch and "G" for glucose, indicate the areas where each of these molecules are located in both diagrams. Be sure you indicate the location of iodine molecules in the "Final State" diagram too.



Initial State



Final State

Part 2—Diffusion of Water Across a Membrane (Osmosis)

Osmosis is a special type of diffusion. Specifically, it is the diffusion of water across a membrane. Osmosis is a very important process because it enables cells to maintain the proper water balance.

Generally water will diffuse across a membrane, resulting in equal concentrations of water on both sides. If the cytoplasm of a cell is 95% water, the remaining 5% is dissolved materials (solute). If the liquid that surrounds the cell has the same concentration of water as the cytoplasm, no net diffusion occurs in either direction. In other words, equal numbers of water molecules move into and out of the cell. If the liquid outside the cell has a higher concentration of water (less solute) than the cytoplasm, water will diffuse into the cell. If the liquid outside the cell has a lower concentration of water (more solute) than the cytoplasm, water will diffuse out of the cell. In this activity, you will place living cells in different solutions and observe the results.



Objectives

By the end of this activity, you should be able to:

- predict what would happen if cells are placed in solutions having different concentrations
- explain how the diffusion of water plays a role in several real-world situations
- prepare wet-mount slides and use appropriate staining techniques
- make observations of biological processes

Materials

- red onion
- cover slips
- water
- dropper/pipette
- glass microscope slides
- distilled water
- colored pencils (red)
- salt solution
- if the salt solution is not provided:
 - triple-beam or electronic balance
 - 10 mL graduated cylinder
 - salt
 - beaker

Safety

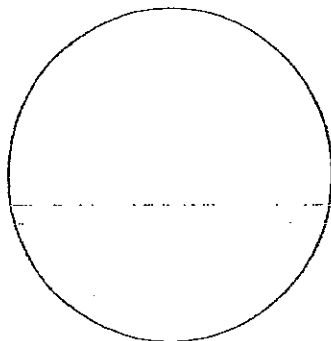
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Handle slides and cover slips with care.

Procedures

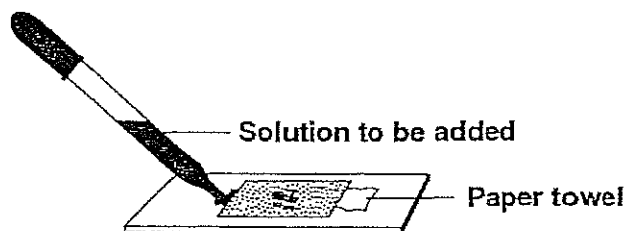
1. If the salt solution is not provided by your teacher, use a balance to measure 1 gram of salt. Measure 10 mL of distilled water with a graduated cylinder. Add both the salt and the water to a 250 mL beaker and mix. This will be your prepared salt solution.
2. Your teacher will provide a small, curved section of an onion for you to use. Break the section in the middle and gently peel off the reddish outer membrane.
3. Position the membrane in a drop of water on a slide. Be careful not to allow the membrane to fold over on itself.
4. Add a cover slip and observe the cells using the low power of a microscope. Choose the magnification that will allow you to see individual cells and their contents. If you do not see any cells with red coloration, search on the slide for cells that do have it. You may need to make another slide.
5. Have your teacher observe your slide with the microscope to be sure you have a good preparation.



6. Based on your observations, draw and color a typical red onion cell mounted in water. Label the cell wall, cell membrane, and cytoplasm.



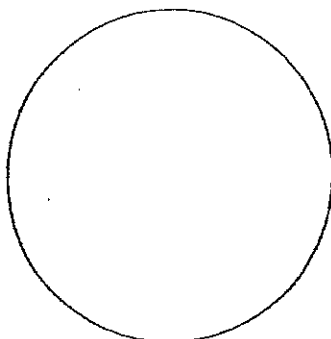
7. Next, without disturbing the slide, add salt solution. You can do this by placing a small piece of paper towel against one edge of the cover slip and adding several drops of the salt solution to the other side. (See diagram below.) The paper towel will soak up the liquid already on the slide and draw the salt solution through. Remove the paper towel before it soaks up too much liquid and dries out the slide.



8. Observe the cells for several minutes. You should see a change in the cells from your previous observation. If not, add more salt solution. Describe the changes you observed in the red onion cells.

9. Have your teacher check your slide with the microscope to be sure you are able to observe the effects of salt on cells.

10. Based on your observations, draw and color a typical red onion cell mounted in salt solution. Label the cell wall, cell membrane, and cytoplasm.





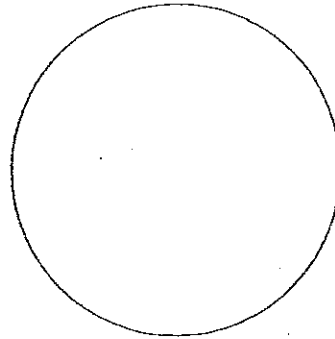
11. Describe what happens to the water content of the red onion cells when they are placed in a salt solution.

12. Replace the salt solution with distilled water. Use the same technique you used in Step 7, but use distilled water instead of salt solution. It may require 20 or more drops to wash all the salt away.

13. Observe the cells for several minutes. Describe the changes that occurred in the red onion cells.

14. Have your teacher check your slide with the microscope to be sure the effects of distilled water are visible.

15. Based on your observations, draw and color a typical red onion cell mounted in distilled water.



Analysis Questions

1. During Part 1 of this laboratory activity, one group of students followed the directions incorrectly. They poured the Starch Indicator Solution into the "cell" and filled the beaker with starch and glucose solution. State how their results would differ from those obtained by students in their class who followed the directions correctly.

2. Some state roads are salted heavily in the winter, creating an environmental problem. Based on observations you made in this laboratory activity, explain how organisms could be harmed by high levels of salt from roadways.



3. When a person in the hospital is given fluid intravenously (an I.V.), the fluid is typically a saline (salt) solution with about the same water concentration as human body tissues. Explain how the use of distilled water in place of this saline solution would be expected to upset the patient's homeostasis. Your answer should refer to the process of diffusion.

4. Many fresh-water one-celled organisms have structures called *contractile vacuoles*. These structures collect and pump out excess water that accumulates in the cell. Name the process that causes water to flow into these organisms. _____ Explain why contractile vacuoles would be of little value to one-celled organisms living in the ocean (salt water).

5. Popcorn sold at most movie theaters is very salty, causing people to become thirsty and buy soft drinks. Describe in scientific terms why the salty popcorn causes this thirst. You should mention changes in specific body cells in your answer.

6. In many animals, glucose, rather than starch, is transported by the blood through the body to all the cells. Starches in many foods are digested to yield glucose. Based on what you learned in this laboratory activity, explain why the digestion of starch to glucose is necessary.

RAW EGG MYSTERY!

PROBLEM:

How will osmosis and diffusion effect a raw egg?

RESEARCH:

The cell is the basic building unit of all living organisms. The human body contains trillions of cells, each working to keep the body alive. Food moves into the cell and waste moves out of the cell through a process called diffusion. Molecules pass through the cell's permeable membrane, flowing from where they are more concentrated to where they are less concentrated. It is difficult to see this process in humans because human cells are so small. But in this experiment you will be able to see the process clearly using a large single cell - a hen's egg.

HYPOTHESIS:

Solutions separated by a membrane tend to become equal in concentration.

EXPERIMENT:

Time needed - 15 minutes for setting up, 5 to 7 days for observations

Materials needed

1 or 2 raw hens' eggs
vinegar (white or distilled is best)
string
white corn syrup (for extra credit)

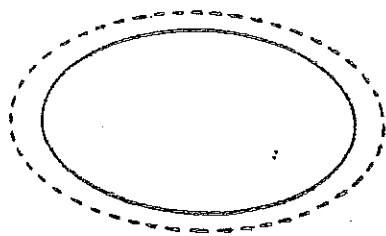
jar, with wide mouth and lid, large enough to hold egg
water
metric ruler

Procedure

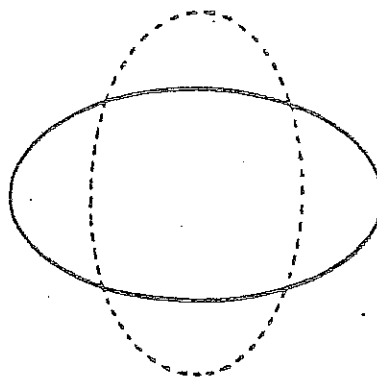
- 1) On Day 1, obtain a raw egg in its shell. There should be NO visible cracks.
- 2) Measure the long and short circumferences (see the illustration on the back) with a string and ruler. Measurements MUST be in centimeters. Enter your measurements on the Data Table under Day 1.
- 3) Place the egg in a jar and cover with vinegar. Make sure there is enough vinegar in jar to cover the egg.
- 4) Screw on the jar lid to prevent evaporation. Record your observations.
- 5) On Day 2, observe the egg without removing it from the jar. Record your observations.
- 6) On Day 3, CAREFULLY remove the egg from the vinegar and gently rinse it with tap water. Observe how the egg looks and feels. Record your observations. Measure the long and short circumferences, and record these measurements on the Data Table under Day 3.
- 7) Remove the vinegar from the jar, thoroughly rinse out the jar. Then fill the jar three quarters full with tap water.
- 8) CAREFULLY place the egg back in the jar. Make sure there is enough tap water to cover the egg. Screw on the jar lid to prevent evaporation.
- 9) On Day 4, observe the egg without removing it from the jar. Record your observations.
- 10) On Day 5, remove the egg from the jar. Measure the long and short circumferences, and record these measurements on the Data Table under Day 5. Observe and record how the egg looks and feels.

EXTRA CREDIT (CONTINUE ON...)

- 11) Remove the water from the jar. Fill the clean jar three quarters full with corn syrup.
- 12) CAREFULLY place the egg back in the jar. Make sure there is enough corn syrup to cover the egg. Screw on the jar lid to prevent evaporation.
- 13) On Day 6, observe the egg without removing it from the jar. Record your observations.
- 14) On Day 7, observe and record how the egg looks and feels. If possible, remove the egg from the jar. If you can, measure the long and short circumferences, and record these measurements on the Data Table under Day 7.



Long circumference



Short circumference

NAME _____

DATE _____
PERIOD _____

RAW EGG EXPERIMENT: OBSERVATIONS AND DATA TABLE

**** Use your 4 senses (DO NOT TASTE!) when writing your daily observations about your Raw Egg.**

DAY 1 OBSERVATIONS: _____

DAY 2 OBSERVATIONS: _____

DAY 3 OBSERVATIONS: _____

DAY 4 OBSERVATIONS: _____

DAY 5 OBSERVATIONS: _____

TURN OVER FOR DATA TABLE AND EXTRA CREDIT OBSERVATIONS...

83

EXTRA CREDIT (CONTINUE ON...)

DAY 6 OBSERVATIONS: _____

DAY 7 OBSERVATIONS: _____

DATA TABLE

DAY	SHORT CIRCUMFERENCE IN CM.	LONG CIRCUMFERENCE IN CM.
1		
2		
3		
4		
5		

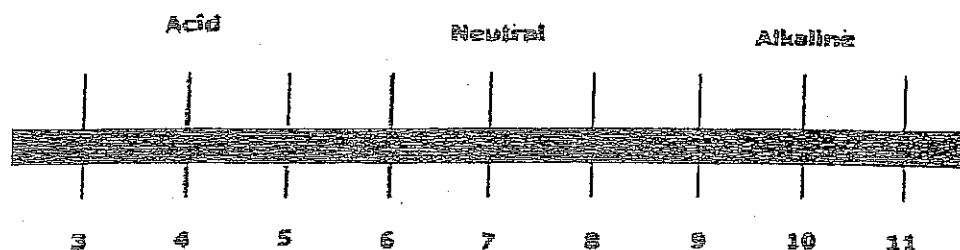
EXTRA CREDIT DATA TABLE

6		
7		

Name _____ Period _____ Date _____
 Biology Lab

Testing pH

Background: pH is the degree of acidity and basicity of a solution. The pH scale ranges from 0-14. This number actually relates to the number of hydrogen ions in solution. A lower pH is an acidic solution and a higher pH is basic or *alkaline*. A pH reading of 7 indicates a neutral solution. In a neutral solution, the number of hydrogen ions is equal to the number of hydroxide ions. Distilled water has a pH of 7. In this investigation, you will determine the pH of various substances. You will also explore the effect of an acid on a base.



Objectives: In this activity you will:

1. Determine the pH of a variety of common substances
2. Perform a neutralization reaction

Materials: List the materials used in this lab

Procedure and Observations: Part I

1. Obtain a small amount of each solution.
2. Before performing any tests, make a prediction as to whether the substance is an acid or base.
3. Dip a fresh strip of red, blue, and wide range pH paper into the substance.
4. Compare the color of the wet paper with the pH chart provided.
5. Record all results in the chart provided.
6. Answer all conclusion questions in complete sentences using your experience in this lab and your knowledge of biology.

Data Table 1: Fill in the chart. Be sure to make your predictions before testing begins.

Substance	Prediction	Red Litmus	Blue Litmus	pH Paper	Acid or Base
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Procedures and Observations: Part II

1. Pour 1 ml of ammonia into a test tube (about 20 drops). Using wide-range pH paper, find the pH. Record it on the chart.
2. Add vinegar, one drop at a time. Be sure to swirl the mixture after every drop of vinegar.
3. After each drop, mix well, test the pH, and record it in your data table. Stop when the pH reaches 7 (neutralization).

Data Table II:

Drops if Vinegar	pH	Drops if Vinegar	pH	Drops if Vinegar	pH
0		9		18	
1		10		19	
2		11		20	
3		12		21	
4		13		22	
5		14		23	
6		15		24	
7		16		25	
8		17		26	

Number of drops of vinegar to neutralize ammonia = _____.

Conclusion Questions:

1. Which solutions were acids?

2. Which solutions were basic?

3. Which solutions were neutral?

4. Did the results using wide-range pH paper agree with the results using red and blue litmus paper?

5. What additional information did the wide-range pH paper provide?

6. What ions in the solution were causing the pH paper to change? Which solution contained the highest concentration of hydroxide ions? How do you know?

7. Explain how the pH scale works. Be sure to include a definition of pH and what pH measures.

8. Draw your own pH scale and write the name of each substance you tested at the point along the scale that corresponds to its pH.

9. What happened to the pH of ammonia as acid was added to it? Explain the results in terms of the chemical reaction that occurred.

10. Predict what would happen to the pH of the ammonia-vinegar solution if you continued to add acid to the tube.

11. What would happen to the pH of water if you added vinegar to it? Explain your answer fully.

12. Explain why ammonia and bleach should never be mixed together.

13. What substances are produced in a neutralization reaction?

14. What substance would be produced by the addition of hydrochloric acid (HCl) to sodium hydroxide (NaOH)? Describe the substance and write the appropriate chemical reaction.

15. Describe why a person with an upset stomach would take Roloids or Tums to ease their pain. What are these products called? Explain.

Lab #14: Fast Food Nutrition Lab

Name _____

Teacher: _____

Period: ____

Date: _____

Due Date: _____

Nutrition and Digestion
Section 39-1

SKILL ACTIVITY-
Analyzing data

Calculating Nutrients Available in Fast Foods

To evaluate the nutritional value of fast foods, it is necessary to analyze their nutrient content. In this activity you will determine the nutrient content of some fast foods.

On average, the caloric needs of a teenager are 2800 Calories per day for males and 2100 Calories per day for females. To achieve a balanced diet, 30 percent of the Calories that you consume should come from fat, 12 percent should come from proteins, and 58 percent should come from carbohydrates. Sodium intake should be limited to about 1800 milligrams per day, or approximately 5 grains of salt.

1. In the chart below are the protein, carbohydrate, fat, and salt content (in grams) of some common fast foods.
 - a. To calculate the Calories per gram of protein or carbohydrate, multiply the number of grams by 4.
 - b. To calculate the number of Calories per gram of fat, multiply the number of grams by 9.
 - c. To calculate the total Calories, add the Calories of protein, carbohydrate, and fat.
 - d. To determine the percentage of Calories, divide the carbohydrate, protein, or fat Calories by the total number of Calories. The first one is done for you.

NUTRIENT CONTENT OF AVERAGE SERVINGS OF FAST FOODS

NUTRIENT CONTENT OF AVERAGE SERVINGS OF SELECTED FOODS											
		Protein Content			Carbohydrate Content			Fat Content			Sodium Content
	Total Calories	in g	in Cal	% Total Cal	in g	in Cal	% Total Cal	in g	in Cal	% Total Cal	(mg)
Hamburger	567	27	108	19	45	180	32	31	279	49	930
Cheese pizza		25			54			15			—
Fish sandwich		16			39			24			725
Fried chicken		74			3			18			940
French fries		3			28			10			—
Milk shake		11			55			10			725
U.S. Dietary Goals				12%			58%			30%	1800 mg/day

2. Which foods are high in fat content? _____
3. Why are these foods high in fat content? _____
4. Which food has the lowest protein content? _____
5. Considering that you should not eat more than 1800 milligrams of salt per day, which foods are high in salt content? _____

VITAMINS

Vitamin	Source	Use
A (carotene)	Yellow and green vegetables, fish-liver oil, liver, butter, egg yolks	Important for growth of skin cells, important for vision, prevents night blindness
D (calciferol)	Fish oils, liver, made by body when exposed to sunlight, added to milk	Important for the formation of teeth and bones
E (tocopherol)	Green leafy vegetables, grains, liver	Needed for proper red blood cell structure
K	Green leafy vegetables, made by bacteria that live in human intestine	Needed for normal blood clotting
B ₁ (thiamine)	Whole grains, liver, eggs, meats, potatoes, milk	Necessary for normal metabolism of carbohydrates
B ₂ (riboflavin)	Milk products, eggs, meats, whole cereal grains	Necessary for normal growth, part of electron transport chain
Niacin	Yeast, liver, milk, fish, whole grains, meats	Important in energy metabolism

6. Using the vitamin chart, list the vitamins, if any, that are contained in each of the fast foods listed below:
 - a. Large hamburger _____
 - b. Cheese pizza _____
 - c. Fish sandwich _____
 - d. Fried chicken _____
 - e. French fries _____
 - f. Milk shake _____

7. Which vitamins are not found in any of the fast foods?
8. If you ate a large hamburger, a medium-size portion of french fries, and a milk shake, what percentage of your recommended daily Calorie intake would you be receiving?
9. Based on your analysis of the nutrient content of fast foods, decide whether the following statements are true or false by circling "T" or "F":
- a. For the amount of nutrients they supply, fast foods are usually too high in Calories.
 - b. Fast foods tend to be high in fat.
 - c. Fast foods tend to be low in protein.
 - d. Many fast foods are high in salt.
 - e. Fast foods are low in vitamins A and K.
10. Explain why the eating of fast foods would not be considered healthy, and describe some of the symptoms that might appear in a person who ate only fast foods.
11. Fast foods can be made more nutritious by adding other types of food to the diet, or by limiting the amount of fast foods that are eaten. Name five ways to make a fast-food diet more nutritious. Concentrate on the following factors: sugar intake, salt intake, vitamin intake, and fat intake.

T
T
T
T
T

CHAPTER 39

Nutrition and Digestion
Section 39-1

SKILL ACTIVITY
Analyzing data

Calculating Nutrients Available in Fast Foods

To evaluate the nutritional value of fast foods, it is necessary to analyze their nutrient content. In this activity you will determine the nutrient content of some fast foods.

On average, the caloric needs of a teenager are 2800 Calories per day for males and 2100 Calories per day for females. To achieve a balanced diet, 30 percent of the Calories that you consume should come from fat, 12 percent should come from proteins, and 58 percent should come from carbohydrates. Sodium intake should be limited to about 1800 milligrams per day, or approximately 5 grams of salt.

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 - b. To calculate the number of Calories per gram of fat, multiply the number of grams by 9.
 - c. To calculate the total Calories, add the Calories of protein, carbohydrate, and fat.
 - d. To determine the percentage of Calories, divide the carbohydrate, protein, or fat Calories by the total number of Calories. The first one is done for you.

NUTRIENT CONTENT OF AVERAGE SERVINGS OF FAST FOODS

		Protein Content			Carbohydrate Content			Fat Content			Sodium Content
	Total Calories	in g	in Cal	% Total Cal	in g	in Cal	% Total Cal	in g	in Cal	% Total Cal	(mg)
Hamburger	567	27	108	19	45	180	32	31	279	49	930
Cheese pizza		25			54			15			—
Fish sandwich		16			39			24			725
Fried chicken		74			3			18			940
French fries		3			28			10			—
Milk shake		11			55			10			225
U.S. Dietary Goals				12%			58%			30%	1800 mg/day

- 4
2. Which foods are high in fat content? _____
 3. Why are these foods high in fat content? _____

 4. Which food has the lowest protein content? _____
 5. Considering that you should not eat more than 1800 milligrams of salt per day, which foods are high in salt content? _____

VITAMINS

Vitamin	Source	Use
A (carotene)	Yellow and green vegetables, fish-liver oil, liver, butter, egg yolks	Important for growth of skin cells, important for vision, prevents night blindness
D (calciferol)	Fish oils, liver, made by body when exposed to sunlight, added to milk	Important for the formation of teeth and bones
E (tocopherol)	Green leafy vegetables, grains, liver	Needed for proper red blood cell structure.
K	Green leafy vegetables, made by bacteria that live in human intestine	Needed for normal blood clotting
B ₁ (thiamine)	Whole grains, liver, eggs, meats, potatoes, milk	Necessary for normal metabolism of carbohydrates
B ₂ (riboflavin)	Milk products, eggs, meats, whole cereal grains	Necessary for normal growth, part of electron transport chain
Niacin	Yeast, liver, milk, fish, whole grains, meats	Important in energy metabolism

6. Using the vitamin chart, list the vitamins, if any, that are contained in each of the fast foods listed below:

- a. Large hamburger _____
- b. Cheese pizza _____
- c. Fish sandwich _____
- d. Fried chicken _____
- e. French fries _____
- f. Milk shake _____

7. Which vitamins are not found in any of the fast foods?
8. If you ate a large hamburger, a medium-size portion of french fries, and a milk shake, what percentage of your recommended daily Calorie intake would you be receiving?
9. Based on your analysis of the nutrient content of fast foods, decide whether the following statements are true or false by circling 'T' or 'F':
- | | | |
|--|---|---|
| a. For the amount of nutrients they supply, fast foods are usually too high in Calories. | T | F |
| b. Fast foods tend to be high in fat. | T | F |
| c. Fast foods tend to be low in protein. | T | F |
| d. Many fast foods are high in salt. | T | F |
| e. Fast foods are low in vitamins A and K. | T | F |
10. Explain why the eating of fast foods would not be considered healthy, and describe some of the symptoms that might appear in a person who ate only fast foods.

11. Fast foods can be made more nutritious by adding other types of food to the diet, or by limiting the amount of fast foods that are eaten. Name five ways to make a fast-food diet more nutritious. Concentrate on the following factors: sugar intake, salt intake, vitamin intake, and fat intake.

Name _____

Date _____

Proteins: Chemistry And Identification

7

Living things are made up of many different chemical molecules. One important group of chemical molecules is proteins. Proteins make up the bulk of all solid material within your body and the bodies of other animals. Your muscle, skin, hair, and inside organs are largely protein. Proteins are essential for body growth and repair. They also make up some hormones which function in chemical control in the body.

In this investigation, you will

- learn how to recognize simple formulas for small molecules called amino acids.
- use models of different amino acids to construct a protein molecule.
- use chemical tests to determine if protein is or is not present in different substances.

Materials



paper models
scissors
dropper
glass marking pencil or labels
test tubes
test tube rack (or tin can)
nitric acid
fingernail clippings
egg white (hard-boiled)
absorbent cotton
dog hair (white)
cream cheese

Procedure

Part A. Models of Protein

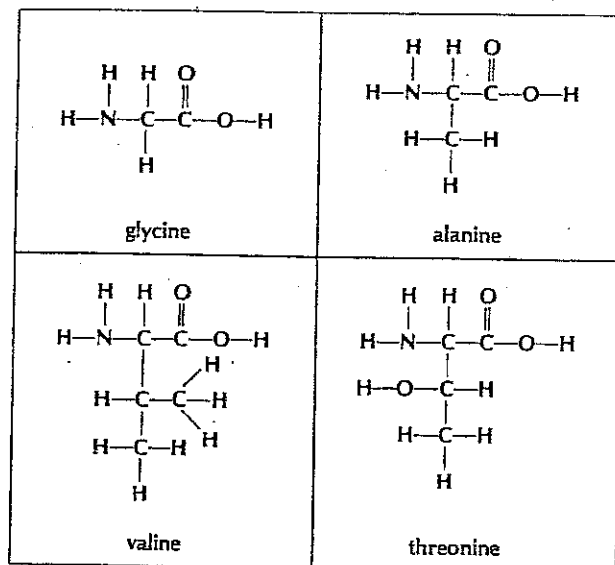
I. Amino Acids, Building Blocks of Protein

Proteins are complex molecules made up of smaller molecules called amino acids. There are about twenty different amino acids found in nature. The element nitrogen (N) is present in all amino acids.

Examine the structural formulas of the four representative amino acids shown in Figure 7-1.

- Name the four elements present in these amino acids. _____

FIGURE 7-1



2. What is the simple formula for the amino

acid (a) glycine? $C_H_O_N_$

(b) alanine? $C_H_O_N_$

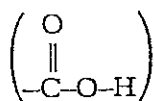
(c) valine? $C_H_O_N_$

(d) threonine? $C_H_O_N_$

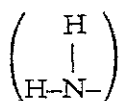
3. How do the simple formulas for all of the

amino acids differ? _____

Note the upper right corner of each amino acid. These ends have a special arrangement of carbon, oxygen, and hydrogen atoms. This end arrangement is called a carboxyl group and looks like this:



4. Circle the carboxyl group on each structural formula in Figure 7-1. Note the upper left corner of each amino acid. These ends have a special arrangement of nitrogen and hydrogen atoms. The end arrangement is called an amino group and looks like this:



5. Use dashed lines to circle the amino groups on the structural formulas in Figure 7-1.

6. In lab 6, you studied carbohydrates.

(a) Do carbohydrates have carboxyl groups?

(b) Do carbohydrates have amino groups?

7. How does the number of hydrogen atoms compare to the number of oxygen atoms in each

amino acid? _____

II. Combining Amino Acids to Form Protein

Amino acids are not protein molecules. They are only the "building blocks" of protein. Several amino acids must be chemically joined in a chain to form a protein molecule. We can show how amino acids join by using models.

Use the paper models given to you by your teacher to complete this section.

• Cut out the four amino acid models. **CAUTION:** Always be extremely careful with scissors. Cut along the solid lines only. Attempt to join the amino acids.

8. Can the amino acid models easily join to form a protein molecule? _____

• Join the molecules by removing as many —OH groups and —H groups as needed from the amino acids. All four amino acid molecules can be joined in this manner to form a protein. Join them in the order valine—threonine—alanine—glycine.

• Join the leftover —OH and —H ends.

9. What chemical substance is formed when the —OH's and —H's are joined? _____

10. How many molecules of water are formed when four amino acids join? _____

11. What chemical compound is formed when the four amino acids are joined? _____

12. Describe the difference between an amino acid molecule and a protein molecule.

There are thousands of different proteins in living organisms. What makes each protein different is the order, number, kind, and arrangement in space of amino acids joined. You only assembled four amino acids into a protein using a specific order.

13. Construct two proteins different from the one you made above. List the order of amino acids here:

(a) _____

(b) _____

Part B. Identification of Proteins

• Number five clean test tubes 1 to 5. Place them in a test tube rack. Using Figure 7-2 as a guide, add the following substances to each test tube:

Name _____

Date _____

- tube 1—fingernail clippings
- tube 2—egg white, hard-boiled
- tube 3—absorbent cotton
- tube 4—dog hair, white
- tube 5—cream cheese

• Add 5 drops of nitric acid to each test tube.

CAUTION: Nitric acid is harmful to skin and clothing. Rinse with water if spillage occurs. Call your teacher.

The test used to identify protein is technically called the xanthoproteic test. A substance containing protein will turn yellow when nitric acid is added to it. No color change to yellow indicates that the substance being tested has no protein.

• Wait several minutes. Then record the color of the items placed in each tube in Table 7-1.

• On the basis of the xanthoproteic test, indicate in the last column of the table if the substances tested do or do not contain protein.

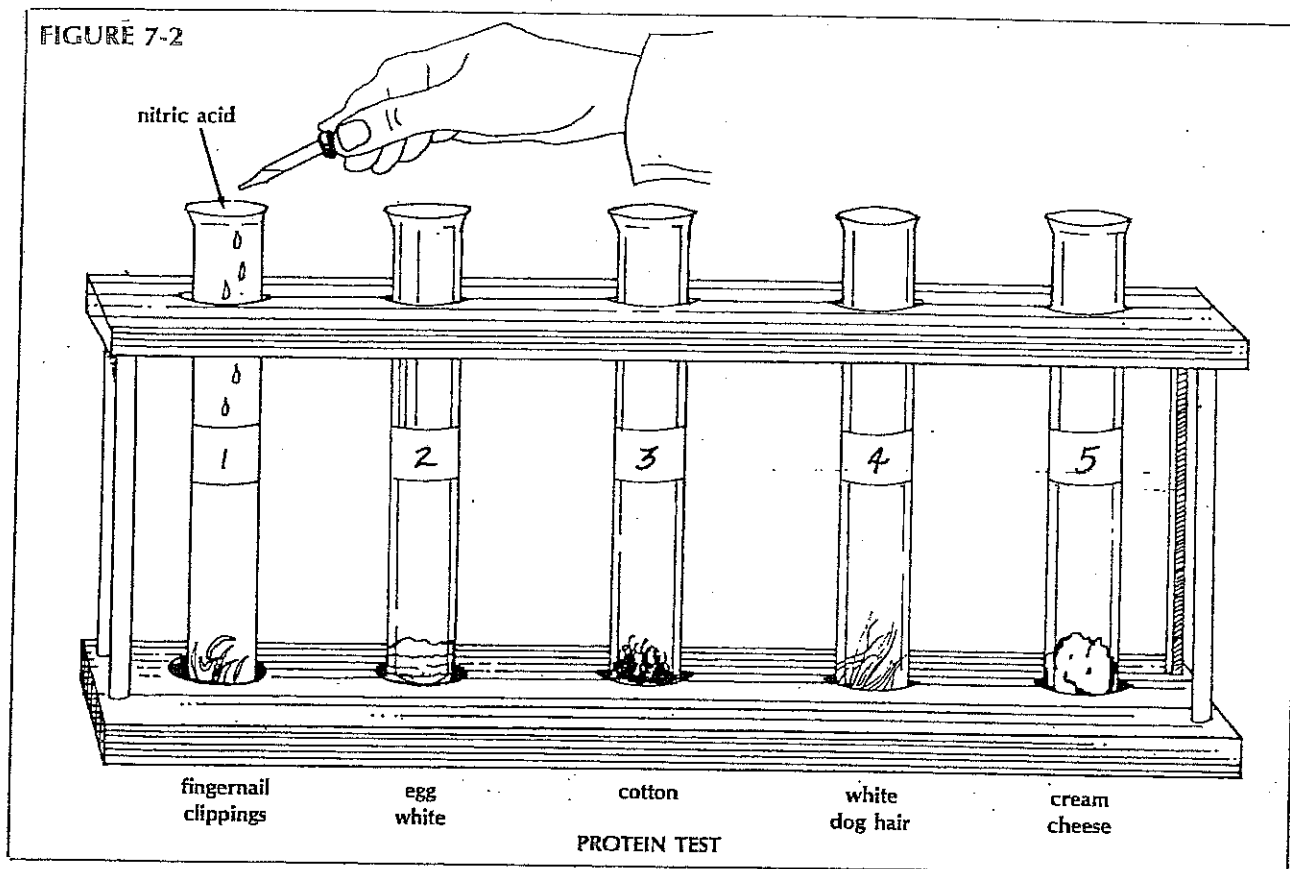


TABLE 7-1. TESTING SUBSTANCES TO DETERMINE IF PROTEINS ARE PRESENT		
SUBSTANCE	COLOR CHANGE DUE TO NITRIC ACID	SUBSTANCE TESTED IS A PROTEIN (ANSWER YES OR NO)
Fingernail		
Egg white		
Cotton		
Dog hair		
Cream cheese		

Analysis

Use your results from Part A to answer questions 1-8.

1. Name four amino acids. _____
2. (a) How many amino acids are there? _____
 (b) How are amino acids used by living things? _____
3. List several of your body parts that are protein. _____

4. Name the four chemical elements present in the amino acids studied (and in all amino acids).

5. Name the two special end groups present in amino acids. _____
6. What element is present in protein (amino acids) that was not present in carbohydrates (Laboratory Investigation 6)? _____
7. Explain how a protein molecule is formed in living organisms. _____

8. Explain how one protein differs from another protein. _____

Use your results from Part B to answer questions 9-13.

9. Describe how to tell if a substance is a protein by using the xanthoproteic test. _____

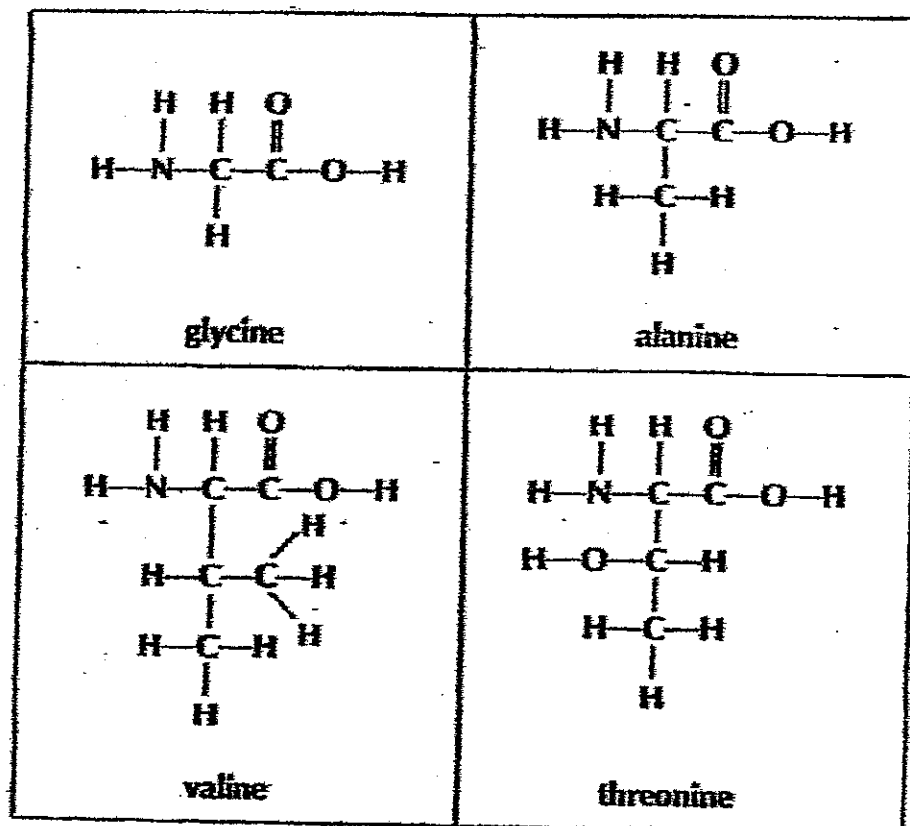
10. (a) List those substances tested that were protein. _____

 (b) List those substances tested that were not protein. _____
11. Using what you have learned about proteins, decide which of the following substances are protein. Place a checkmark on the line next to each substance that is protein.

(a) hamburger _____	(e) liver _____
(b) chicken _____	(f) human hair _____
(c) peanut oil _____	(g) stomach _____
(d) maple syrup _____	(h) 207 amino acids joined _____

12. In Latin, the word "xantho" means yellow, and "proteic" means protein. Why is "xanthoproteic" a meaningful word to use when describing the chemical test used for identifying a protein?

FIGURE 7-1



Name _____

Date _____

Fats: Chemistry And Identification

8

Fats are present in living organisms. These chemicals make up certain parts of your body. Fats are often stored when present in excess and also serve as an energy source. Fats are an important part of our diet.

In this investigation, you will

- learn that all fat molecules are made up of two kinds of smaller molecules, glycerol and fatty acids.
- use structural formulas and models of glycerol and fatty acids to determine how these molecules join to form fat molecules.
- learn how to use the solubility test to tell if a substance is a fat.
- learn how to use the brown paper test to tell if a substance is a fat.

Materials



scissors
paper models
clock or watch with second hand
dropper
glass marking pencil or labels

test tubes
test tube rack
olive, corn, or peanut oil
water
brown paper

unknown substance X
unknown substance Y
unknown substance Z
lighter fluid
test tube stoppers—2

Procedure

Part A. Models of Fats

To better understand the chemistry of fats, it is helpful to study first the small molecules which join to make up fats. Fat molecules are made up of two small "building blocks," or chemical molecules. These molecules are called glycerol and fatty acids.

Glycerol

Figure 8-1 shows the structural formula of glycerol.

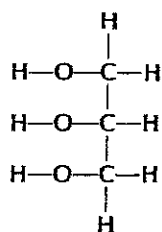


FIGURE 8-1

glycerol

- What elements are present in glycerol?

- Are there any elements in glycerol that are not in carbohydrates? _____

- What is the simple formula for glycerol? (Add the number of atoms of each element and

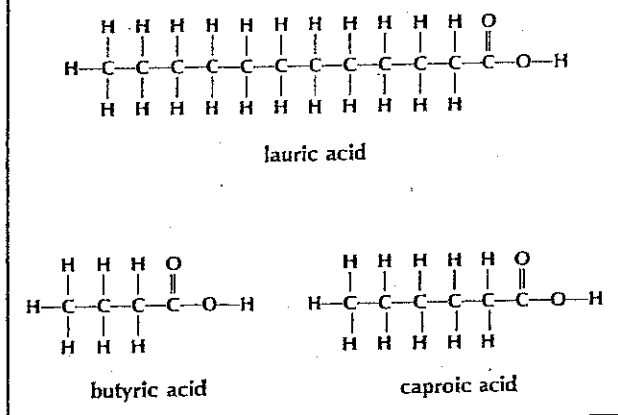
record the totals.) C__ H__ O__

- Are there two times as many hydrogen atoms as oxygen atoms in glycerol? _____

Fatty Acids

The second kind of molecule which is part of a fat is a fatty acid. Many different fatty acids exist, but all are similar in several ways. Butyric acid, caproic acid, and lauric acid are examples of fatty acids. Figure 8-2 shows the structural formulas for these three fatty acids.

FIGURE 8-2



- Examine the structural formulas for these three molecules.

5. What elements are present in all fatty acids?

6. (a) What is the simple formula for butyric

fatty acid? $C_H_O_$

(b) What is the simple formula for caproid

fatty acid? $C_H_O_$

(c) What is the simple formula for lauric

fatty acid? $C_H_O_$

7. How do the number of hydrogen atoms compare to the number of oxygen atoms in

each fatty acid? _____

8. How many oxygen atoms are present in each

fatty acid? _____

9. Note the end of butyric acid containing the oxygen atoms. This special end arrangement of carbon, hydrogen, and oxygen is called a

carboxyl group $\left(\begin{array}{c} O \\ || \\ -C-O-H \end{array} \right)$. Is the carboxyl

group present in all fatty acids shown? _____

10. (a) List a similarity between glycerol and fatty acids. _____

(b) Do fatty acids and glycerol both contain a carboxyl group? _____

Combining Glycerol and Fatty Acids to Form Fats

A fat molecule consists of one glycerol molecule and three fatty acid molecules joined.

- Cut out the glycerol and fatty acid paper model molecules given to you by your teacher. **CAUTION:** Always be extremely careful with scissors. Cut along the solid lines only. Attempt to construct a fat molecule.

11. Will the fat molecule fit together as pieces in a puzzle? _____

- Remove three $-OH$ ends from the glycerol molecule and three $-H$ ends from the fatty acids. Now join the molecules to form a fat.

12. (a) How many glycerol molecules are needed

to form a fat molecule? _____

(b) How many fatty acid molecules are needed

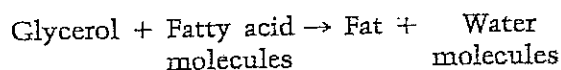
to form a fat molecule? _____

- Join the leftover $-H$ and $-OH$ ends from your models.

13. What chemical substance is formed when the

$-H$ and $-OH$ ends are joined? _____

Production of a fat molecule is a chemical reaction. A chemical shorthand way of expressing the formation of a fat is as follows:



14. How many water molecules are formed when

one fat molecule is produced? _____

Many fats exist in living things. The wide variety of fats are formed by different combinations of fatty acid molecules.

15. A change in the type of fatty acid results in a different type of a fat molecule. What mole-

cule remains unchanged in all fats? _____

Part B. Identification of Fats

Two different tests can be used to determine the presence of a fat, the solubility test and the brown paper test.

Solubility Test on Known Fats

- Label two test tubes one and two.

- Use Figure 8-3 as a guide to filling your test tubes. **CAUTION:** Lighter fluid is flammable. Extinguish all flames in the laboratory before proceeding. Avoid breathing fumes.

Name _____

Date _____

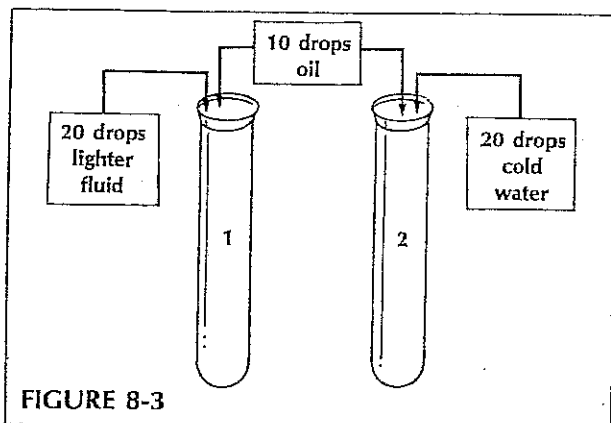


FIGURE 8-3

- Mix contents of each tube by placing a stopper over the opening of each tube. Place your thumb over the stopper and shake each tube 10 times.
- Wait one minute.
- Examine and compare both tubes. Fats are soluble in lighter fluid. Soluble means that they dissolve or mix. The liquid in the tube should look like Figure 8-4A in which only one liquid is seen.
- Fats are not soluble in cold water. They do not dissolve or mix. Two layers will be seen as shown in Figure 8-4B.

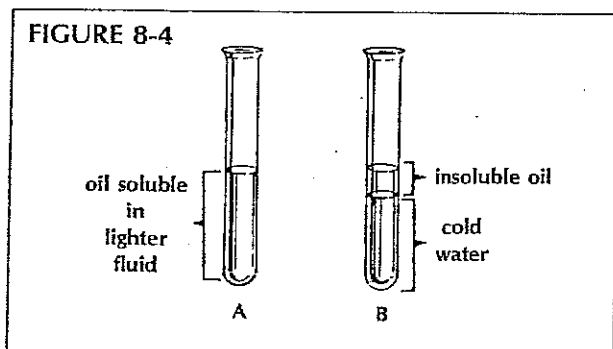


FIGURE 8-4

- Record in Table 8-1 how the oil appears when mixed with lighter fluid and cold water.

Brown Paper Test for Fats

- On separate pieces of brown paper, rub one drop of oil and one drop of water (Figure 8-5). Oil is a fat. Water is not.

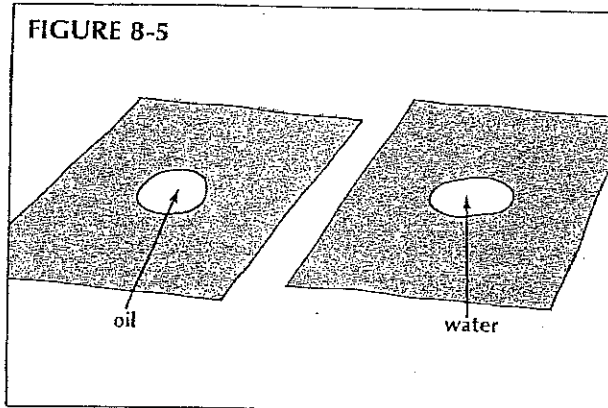


FIGURE 8-5

- Allow the paper to dry for a few minutes.
- Hold the paper toward light. If light passes through, a translucent (semitransparent) spot has formed.
- Examine the pieces of paper to check for a translucent spot. Record in Table 8-1 how fats and water appear when spotted on brown paper. Fats should give a translucent spot, water should not.

Testing Unknown Substances for Fats

- Perform the lighter fluid solubility and brown paper tests on each of the following substances:

- substance X
- substance Y
- substance Z

NOTE: Use very small amounts of X, Y, and Z if they are not liquid.

- On the basis of your observations, indicate in the last column of Table 8-2 whether or not each substance contains fats.

TABLE 8-1. RESULTS OF TESTS ON FATS	
TEST	RESULTS
Fats mixed with lighter fluid	
Fats mixed with cold water	
Fats rubbed on brown paper	
Water rubbed on brown paper	

54

TABLE 8-2. TESTING UNKNOWN SUBSTANCES FOR FATS (ANSWER YES OR NO)

SUBSTANCE	TEST			RESULTS
	SOLUBLE IN		TRANSLUCENT SPOT FORMED ON PAPER	FAT PRESENT
	LIGHTER FLUID	WATER		
X				
Y				
Z				

Analysis

Use your results from Part A to answer questions 1 to 3.

- Name the types of molecules and number of each type needed to form a fat molecule. _____
- List two ways that a fatty acid molecule differs from glycerol. _____
- Complete the following chart by using "yes" or "no" answers.

TABLE 8-3. SUMMARY OF GLYCEROL, FATTY ACIDS, AND AMINO ACIDS

	GLYCEROL	FATTY ACIDS	AMINO ACIDS
Carbon present			
Hydrogen present			
Oxygen present			
Nitrogen present			
Double the amount of hydrogen as oxygen			
Has a carboxyl group			
Has an amino group			
Molecules join to form fats			
One molecule loses 3 OH ends			

Use your results from Part B to answer question 4.

- Explain why grease on clothing will not come out with cold water. _____

ALCOHOLIC FERMENTATION
ANAEROBIC RESPIRATION

NAME: _____

DATE: _____

LAB # 16

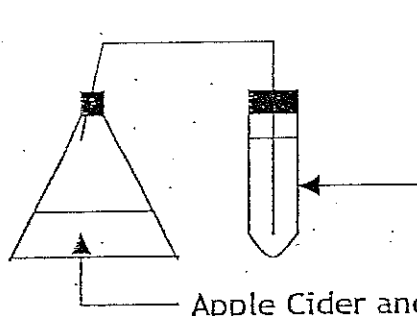
DATE DUE: _____

AIM: To study how yeast cells change sugar into alcohol by fermentation.

MATERIALS: yeast, fresh apple cider, bromo-thymol blue

PROCEDURE: 1. Stir some yeast into a jar of fresh apple cider.
2. Fill a test tube with water, add a few drops of brom-thymol blue, and place the test tube in a beaker so that none of the liquid in the test tube spills.
3. Connect the jar and the test tube with bent glass tubing so that your finished setup looks like the diagram below.

Bromo-thymol Blue and Water



- Apple Cider and Yeast
4. Label your setup with your name and allow it to stand for at least 48 hours.
 5. After 48 hours, filter the cider with cheese cloth to remove the yeast sludge at the bottom of the jar.
 3. Taste the filtered cider.

DISCUSSION:

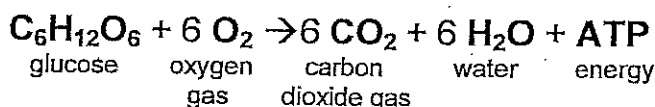
1. What evidence exists to indicate that the yeast cells in the cider produced carbon dioxide?
2. What evidence is there that the apple cider has turned to alcohol?
3. Limewater is also used to indicate the presence of carbon dioxide. Explain what you would see if limewater had been substituted for brom-thymol blue?
4. Define fermentation.
5. Write a word equation to show what happened in the procedure.
6. Most wines have a fairly constant percentage of alcohol (10-12%). If you let the cider ferment for a longer period of time the alcohol content will not increase. Explain why.

Cellular Respiration in Yeast

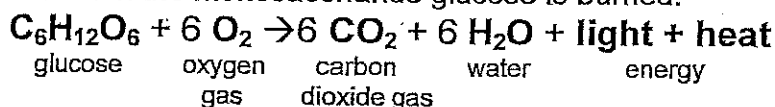
Adapted from "Alcoholic Fermentation in Yeast Investigation" in the School District of Philadelphia Biology Core Curriculum © 2008 by Jennifer Doherty and Dr. Ingrid Waldron, University of Pennsylvania Biology Department¹

All living cells, including the cells in your body and the cells in yeast, need energy for cellular processes such as pumping molecules into or out of the cell or synthesizing needed molecules. **ATP** is a special molecule which provides energy in a form that cells can use for cellular processes.

Cellular respiration is the process that cells use to transfer energy from the organic molecules in food to ATP. The following equation summarizes the chemical changes that occur in cellular respiration of the monosaccharide glucose when oxygen is available.



The chemical reactions in cellular respiration are similar to the chemical reactions when organic compounds are burned, but of course no ATP is produced. Instead energy is released in the form of light and heat. The following equation shows the chemical changes that occur when the monosaccharide glucose is burned.

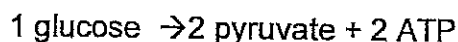


What are the similarities between this equation for burning glucose and the equation for cellular respiration of glucose when oxygen is available?

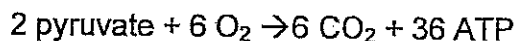
What is the difference between these equations?

There is another important feature of cellular respiration which is not shown in these equations. Cellular respiration involves many small steps; these multiple steps allow the cell to use the energy from each glucose molecule efficiently in order to make as many ATP molecules as possible. The multiple steps of cellular respiration are described in your textbook. Our description will focus on some major steps and how these steps differ, depending on whether oxygen is available or not.

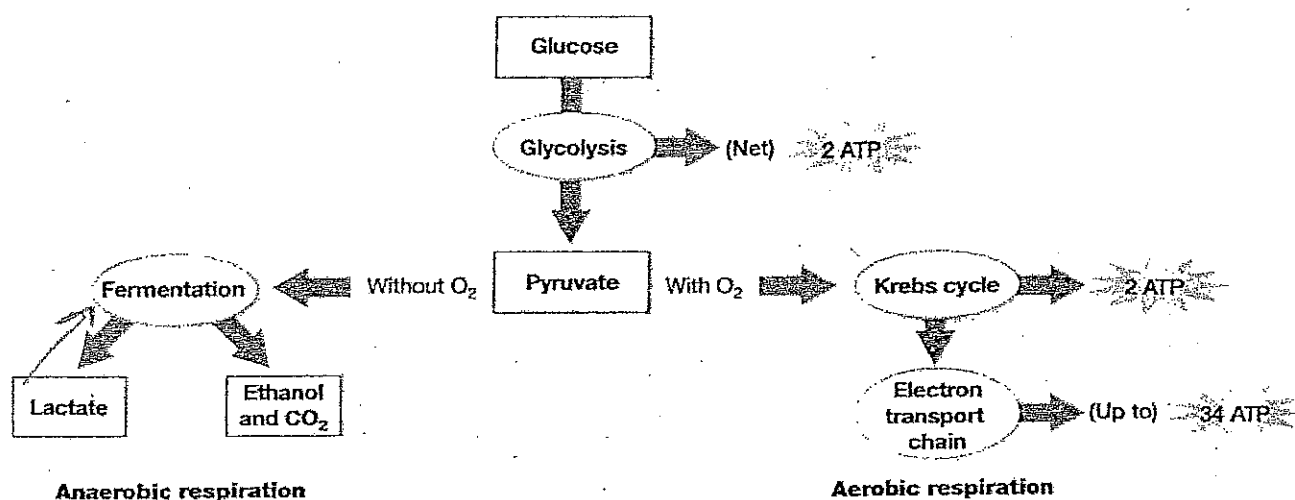
The first major step in cellular respiration is **glycolysis** (see the figure on the top of page 2):



What happens next depends on whether or not oxygen is available to the cells. When oxygen is available, cells can use the **Krebs cycle** and the **electron transport chain** to make up to 36 ATPs (see the right side of the figure).



Cellular respiration that uses O_2 is called **aerobic respiration**. Most of the time, the cells in our bodies use aerobic respiration:



When oxygen is not available, cells can use a process called **fermentation** to keep making energy. This is called **anaerobic respiration**. (The "an" in front of aerobic means "not aerobic".)

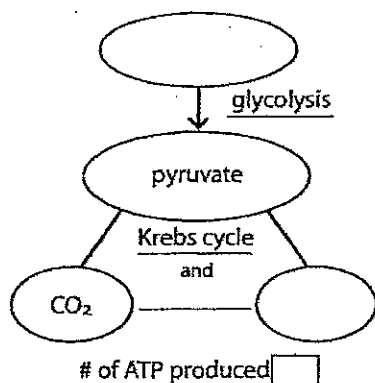
As shown in the figure above, there are two types of fermentation:

lactate fermentation (e.g. in muscles when an animal exercises hard) and **alcoholic fermentation** (e.g. by yeast to make wine and beer).

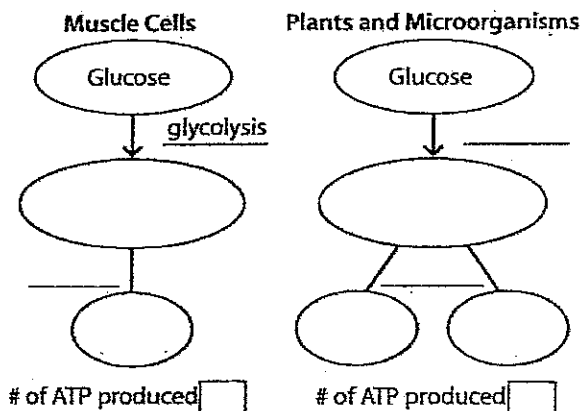
Fermentation has two disadvantages compared to aerobic respiration. Fermentation produces much less ATP than aerobic respiration, and fermentation produces a toxic byproduct (either lactate, which becomes lactic acid, or alcohol). However, fermentation is very useful if oxygen is not available.

Use the above information to complete the figures below. Fill in the ovals with the appropriate molecule. On the blank lines write the name of the appropriate process. In the boxes at the bottom of the figure write how much ATP is made in each pathway.

With Oxygen (Aerobic)



Without Oxygen (Anaerobic)



Humans use **yeast** every day. What is yeast? What are some common uses of yeast?

If you want to make your own bread, you can buy yeast in the grocery store. This yeast consists of little brown grains. The little brown grains of yeast may not seem to be alive, but if you put them in water with sugar, the yeast will carry out cellular respiration and grow.

You can grow yeast in a test tube filled with water and sealed with a balloon. Do you think these growth conditions are aerobic or anaerobic?

Under anaerobic conditions, yeast carries out alcoholic fermentation, so it produces _____ and _____. You can measure the rate of anaerobic respiration in yeast by measuring the amount of carbon dioxide gas the yeast produces. Carbon dioxide production can be measured by measuring the depth of the layer of bubbles trapped in foam on top of the yeast solution and also by observing the balloons, which catch the carbon dioxide produced and get bigger.

Part I - Sucrose Concentration

What is sucrose?

Your first experiment will investigate the effect of sucrose concentration on the rate of cellular respiration in yeast. Yeast can convert sucrose into glucose and use it during cellular respiration.

You will design an experiment to answer the question: Does the concentration of sucrose affect the rate of cellular respiration in yeast?

Your teacher will provide you with yeast, test tubes, balloons, rulers, and four concentrations of sucrose water: 0% (plain water), 1%, 5% and 10% sucrose.

1. Write a hypothesis that you will test to help you answer the research question.
2. What will be the independent variable in your experiment?
3. What will be the dependent variable in your experiment?
4. What will be the control treatment in your experiment?

What is the purpose of this control treatment?

5. The basic procedure to measure cellular respiration is:
- 1) Add 25 mL of the appropriate sucrose solution to each tube.
 - 2) Add $\frac{1}{4}$ tsp of yeast to each tube.
 - 3) Put a balloon on the top of each tube.
 - 4) With your palm sealing the top, shake each tube until the yeast is dissolved.
 - 5) Measure the depth of bubbles produced and observe how the balloons change after 10 minutes and 20 minutes.

Write your specific procedures here:

6. Complete the first column of these data tables.

	Depth of CO ₂ bubbles in:	
Sucrose treatment	10 minutes	20 minutes

	Balloon description	
Sucrose treatment	10 minutes	20 minutes

7. Perform your experiment and record your data in the data tables.

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8. Did the yeast produce different amounts of carbon dioxide with different sucrose concentrations?

Do the results match your hypothesis?

9. Discuss your results with your group. What conclusions concerning the relationship between sucrose concentration and the rate of cellular respiration are supported by your results?
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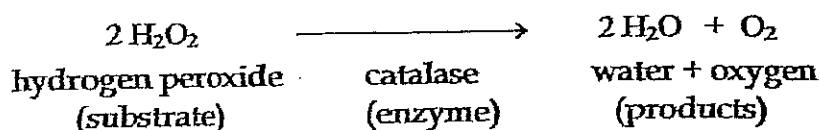
Name: _____

Date: _____

Lab: Enzyme Activity

Background: Have you ever cut your finger and put peroxide on the cut? What happens? Yes, the peroxide foams!! Has your dentist ever asked you to rinse your mouth with a weak peroxide solution? What happens? Your mouth foams!! Why does this happen to us? ~~There are thousands of chemical reactions taking place in your cells.~~ Almost all of these reactions require molecules called enzymes.

Enzymes are protein molecules that change the rate of chemical reactions without being used up or changed by the reaction. They act just like catalysts. That is why they are called "biological catalysts". The shape of an enzyme enables it to "fit" with a particular substance, called a substrate. A specific enzyme is required for each chemical reaction. Without the help of thousands of different kinds of enzymes, the chemical reactions in your body would happen too slowly for you to survive. Living cells produce a toxic waste called hydrogen peroxide. Cells synthesize an enzyme called catalase that breaks down hydrogen peroxide to form harmless end products.



The amount of catalase present within certain cells can be determined by comparing the amount of oxygen bubbles released when these cells are placed in hydrogen peroxide. In this investigation, we will compare the amount of catalase in plant and animal cells.

Problem: What are the effects of temperature and pH on the activity of enzymes in plant and animal cells?

Form a Hypothesis:

Materials:

6 test tubes	potato samples
graduated pipet	liver samples
3% hydrogen peroxide	test tube rack

Procedure:

Part A: 1. Number the test tubes 1 - 3 and place them in the rack.

2. Add the following to each tube:

Tube 1: small chunk of raw potato

Tube 3: Nothing (control)

3. Using a pipet, add 1 mL H_2O_2 to each tube.
4. Observe the amount bubbling or foam (oxygen gas being given off) in each tube. Using the scale of 0-4, record the amount in your data table.

Part B - Effect of Temperature: Repeat steps 1-4 from Part A, using the cooked liver and potato sample.

Part C- Effect of pH: Repeat steps 1-4 from Part A, using foods soaked in acid.

Observations:

Data Table: Use the scale on the right to estimate the rate of the reaction.

Type of Cell	Raw	Cooked	Acid
Potato			
Liver			
Control			

Scale:

- 0 = No reaction
- 1 = slow reaction
- 2 = moderate reaction
- 3 = rapid reaction
- 4 = extremely rapid reaction

Analysis: (Answer on a separate sheet of paper)

1. List three properties of all enzymes.
2. In this laboratory exercise, which was the enzyme? Which was the substrate?
3. What was the source of the enzyme?
4. How were you able to determine the amount of enzyme present?
5. Which contained more catalase: plant or animal cells? Explain why you think that would be the case?
6. Why is it important that heat not be used to start a chemical reaction in living cells?
7. Which substance changes during the reactions? the hydrogen peroxide, the food, or both?

Conclusion: (Write 1 paragraph)

Describe the effect of temperature and pH on the rate of enzyme actions as shown by this experiment. How do your results compare with your hypothesis? How can we apply this knowledge to the enzymes found in our own bodies? What temperature do you think they work best at? What pH do you think they work the best?

Name _____ Period _____

Date _____

Dehydration Synthesis & Hydrolysis

Introduction:

96% of all living matter is composed of only four elements -- Hydrogen, Carbon, Oxygen, and Nitrogen. The four main **macromolecules** (carbohydrates, lipids, proteins, and nucleic acids) differ from each other in the number and arrangement of these four elements. The basic processes involving the construction and destruction of these macromolecules are all the same. The process that constructs the molecules is known as **dehydration synthesis**. The process that breaks these molecules down is known as **hydrolysis**.

Objectives:

- Students will demonstrate the processes of dehydration synthesis by combining the **monomers** of carbohydrates (known as **monosaccharides**)
- Students will demonstrate the process of hydrolysis by breaking the polysaccharide into its monomers

Materials:

- Scissors
- Paper molecules
- Adhesive

Procedures:

- 1) Carbohydrates are sugars and starches. They contain Carbon, Hydrogen and Oxygen in a uniform pattern. This pattern is exemplified by the simple formula CH_2O . Notice the H_2O part of the formula. It represents the molecule we called _____. Simply put it is the hydrate in carbohydrates.
- 2) All carbohydrates fall into three main categories: monosaccharides (simple sugars), disaccharides (double sugars), and polysaccharides (complex sugars). On the next page find three monosaccharide sugars. Count up the number of carbons (C), hydrogens (H), and oxygens (O) in each of the molecules.